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Final report

Urban environmental protection international

Stock-taking and outlook

by:

Frederic Rudolph, Thomas Adisorn, Eva Amon, María Rosa Muñoz Barriga, Shritu Shrestha, Chun Xia
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Abstract: Urban environmental protection international

The aim of this study is to contribute to a process of learning about innovative and successful approaches to tackle problems and challenges of urban environmental protection. For this purpose, a detailed overview of the importance of environmental challenges, political priorities and successful solutions in selected countries and cities is provided. On this basis, the study analyses factors of success and it discusses, to what extent such success factors found in the case studies can be transferred to and replicated in other cities. Finally, recommendations are provided to cities, countries and the international community how to further strengthen environmental protection at the urban level. The role of German cities and institutions is discussed as well.

The cases which are analysed are Belo Horizonte in Brazil, Moscow in Russia, Kochi in India, Beijing in China, Cape Town in South Africa and Jakarta in Indonesia. These cities were selected because they already implemented successful policies, measures and other initiatives in the past and the aim of this study is to find and discuss such successful activities. For each city, the study analyses the policy documents to describe challenges and political priorities. These documents are urban land-use plans (cross-sectoral), sectoral master plans as well as concrete urban policies and by-laws. The analysis aims to understand the effectiveness of the plans and instruments and also takes into account the national policy environment. Although taking a cross-sectoral perspective, the analyses each focus on certain sectors to receive in-depth results. The factors of success are deducted in a way the sectoral perspective can be opened up to a more holistic view about success factors.

Kurzbeschreibung: Urbaner Umweltschutz International

Das Ziel dieser Studie ist es, zu einem Lernprozess über innovative und erfolgreiche Ansätze zur Bewältigung von Problemen und Herausforderungen des städtischen Umweltschutzes beizutragen. Zu diesem Zweck wird ein detaillierter Überblick über die Bedeutung von Umweltherausforderungen, politischen Prioritäten und erfolgreichen Lösungen in ausgewählten Ländern und Städten gegeben. Darauf aufbauend analysiert die Studie konkrete Erfolgsfaktoren und diskutiert, inwieweit diese auf andere Städte übertragen und repliziert werden können. Abschließend werden Empfehlungen für Städte, Länder und die internationale Gemeinschaft ausgesprochen, wie der Umweltschutz auf städtischer Ebene weiter gestärkt werden kann. Dabei wird auch die Rolle der deutschen Städte und Institutionen diskutiert.

Die analysierten Fallstudien umfassen Belo Horizonte in Brasilien, Moskau in Russland, Kochi in Indien, Peking in China, Kapstadt in Südafrika und Jakarta in Indonesien. Diese Städte wurden ausgewählt, da sie in der Vergangenheit bereits erfolgreiche Politiken, Maßnahmen und andere Initiativen umgesetzt haben. Das Ziel dieser Forschungsstudie ist es, diese erfolgreichen Aktivitäten ausfindig zu machen und zu erörtern. Für jede Stadt analysiert die Studie einschlägige politische Dokumente, um die jeweilig zutreffenden Herausforderungen und politischen Prioritäten darzustellen. Solche Dokumente sind sektorübergreifende Strategien, sektorale Masterpläne sowie konkrete städtische Maßnahmen und Verordnungen. Die Analyse zielt darauf ab, die Effektivität der Pläne und Instrumente unter Berücksichtigung des nationalen politischen Umfelds zu verstehen. Trotz der sektorübergreifenden Herangehensweise konzentriert sich die Analyse der jeweiligen Fallstudien auf bestimmte Sektoren, um fundierte Ergebnisse zu erzielen. Die Erfolgsfaktoren, die basierend auf dieser sektoralen Analyse herausgearbeitet werden, werden in einen ganzheitlichen Kontext gesetzt, um verallgemeinerbare Aussagen über Erfolgsfaktoren treffen zu können.

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ABC-Plan	Low-Carbon -Agricultural Plan
ABES	Associação Brasileira de Engenharia Sanitaria e Ambiental
Abrelpe	Brazilian Association of Public Cleaning and Special Waste Companies
ACLU	Community Agent for Urban Cleaning
ADB	Asian Development Bank
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
ANA	National Water Agency
APP	Permanent Preservation Area
APPCAP	Air Pollution Prevention and Control Action Plan
AQA	Air Quality Act
AQMP	Air Quality Management Plan
AQMS	Air Quality Monitoring Network System
BAPPEDAS	Municipal planning agencies in Indonesia
BAPPENAS	Ministry of National Development Planning
BAT	Best available technologies
Bau	Business as usual
BEE	Bureau of Energy Efficiency
BERST	Bioeconomy Regional Strategy Toolkit
BH	Belo Horizonte
BHTrans	Transport and Transit operator of Belo Horizonte
BMC	Biodiversity Municipal Corporation
BMU	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BRT	Bus rapid transit system
CAI-Asia	Clean Air Initiative for Asian Cities Center
CAIT	Climate Data Explorer
CAR	Rural Environmental Registry of the Ministry of the Environment
CAT	Climate Action Tracker
c-bed	Centre for Heritage, Environment and Development
CBD	Convention on Biological Diversity
CCAFS	Climate Change, Agriculture and Food Security
CDH	Cliffe Dekker Hofmeyr
CDP	Kochi City Development Plan

CEPAL	Economic Commission for Latin America and the Caribbean
CEPI	Compressive environmental pollution index
CHP	Combined heat and power plant
CMMCE	Municipal Committee of Climate Change and Eco-efficiency
CNG	Compressed Natural Gas
CO	Carbon monoxide
Comam	Municipal Council of the Environment
Conabio	National Biodiversity Commission
Conama	National Environmental Council
Copasa-MG	Companhia de Saneamento de Minas Gerais
CPBC	Central Pollution Control Board
CPC	Communist Party of China
CSE	Centre for Science and Environment
CSP	City Sanitation Plan
db	decibel
DEA	Department of environmental affairs
DIM	Dharma Ina Mandiri - Indonesian environment and management firm
DWS	National Department of Water and Sanitation of South Africa
EC	Energy Conservation
ECOSOC	Economic and Social Council
EDF	Environmental Defence Fund
EESL	Ministry of Power and Energy Efficiency Services Limited
e.g.	Exempli gratia
EMS	Minimum emissions standards
ENVASS	Environmental Assurance
EPCA	Environment Pollution Prevention and Control Authority
EV	Electric vehicles
FAO	Food and Agriculture Organization of the United Nations
FAR	Floor area ratio
FCA	Fiat Chrysler Automobiles
FMDA	Municipal Environmental Defence Fund
FYP	Five-Year Plans
GBPN	Green Buildings Performance Network

GCDA	Greater Cochin Development Authority
GEF	Global Environmental Facility
GGEI	Global Green Economy Index
GHG	Greenhouse gases
GII	Gender Inequality Index
GIZ	German Corporation for International Cooperation
GRIHA	Green rating for integrated habitat assessment
HC	Hydrocarbons
HDI	Human Development Index
HEJN	Highveld Environmental Justice Network
HUDCO	Housing and Urban Development Corporation
Ibama	Brazilian Institute for the Environment and Renewable Resources
IBGE	Brazilian Institute of Geography and Statistics
IBSAP	Indonesian Biodiversity Strategy and Action Plan
ICCSR	Climate Change Sectoral Roadmap
ICCT	International Council on Clean Transportation
ICLEI	Local Governments for Sustainability
ICT	Information and communication technology
ICMBio	Chico Mendes Institute for the Conservation of Biodiversity
IEA	International Energy Agency
IETA	International Emissions Trading Agency
IGDP	Innovative Green Development Programme
IIT	Indian Institute of Technology
IMEP	Integrated Metropolitan Environmental Policy
iNDCs	Intended Nationally Determined Commitments
INEI	Analytical Centre for the Government of the Russian Federation
INPE	National Institute for Space Research
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IRG	Indian Road Congress
IRP	Integrated Resource Electricity Plan
ISA	Instituto Socioambiental
ITDP	Institute for Transportation and Development Policy
JCDS	Jakarta Coastal Defence Strategy
JEDI	Jakarta Emergency Dredging Initiative

KfW	Kreditanstalt für Wiederaufbau
KMC	Kochi Municipal Corporation
KMRL	Kochi Metro Rail Limited
KOC	Corporation of Kochi
KSEB	Kerala State Electricity Board
KSUDP	Kerala Sustainable Urban Development Product
KSPCB	Kerala State Pollution Board
KWA	Kerala Water Authority
LCLUC	Land-Cover/Land-Use Change Program
LOA	Budget Law, included in Ibama
LoC	Library of Congress
LPG	Liquefied petroleum gas
LULUCF	Land use, land use change and forestry
LR	Legal Reserve
LSE	Grantham Research Institute on Climate Change and the Environment
MAC	Maximum allowable concentration
MAPA	Ministry of Agriculture of Brazil
MCC	Moscow Central Circle
MCidades	Ministry of the Cities of Brazil
MCTIC	Ministry of Science, Technology, Innovation and Communication of Brazil
MDWS	Ministry of Drinking Water and Sanitation of India
MEE	Ministry of Ecology and Environment of People's Republic of China
MEP	Ministry of Environmental Protection of People's Republic of China
mg	milligram
MIC	Mobility in Chain
m3	Cubic metre
mld	Million litres a day
MLR	Ministry of Land and Resources of People's Republic of China
MMA	Ministry of Environment of Brazil
MMVD	Maharashtra Motor Vehicle Department
MNRE	Ministry of New and Renewable Energy
MoEF	Ministry of Environment and Forests
MoEFCC	Ministry of Environment, Forests and Climate Change
MoENR	Ministry of Energy and Natural Resources

MoHUA	Ministry of Housing and Urban Affairs
MoHURD	Ministry of Housing and Urban-Rural Development
MoP	Ministry of Power
MoRTH	Ministry of Road Transport and Highways
MoST	Ministry of Science and Technology of the People's Republic of China
MoT	Ministry of Transport of Indonesia
MoUD	Ministry of Urban Development of India
MP	Provisional measure
MPWH	Government of Indonesia
MSW	Municipal solid waste
MSWM	Municipal solid waste management
MWR	Ministry of Water Resources of the People's Republic of China
NAAQS	National Ambient Air Quality Standards
NAMP	National Ambient Air Quality Monitoring Programme
NAP	National Action Plan
NAPCC	National Action Plan on Climate Change
NBR	The National Bureau of Asian Research
NBSAP	National Biodiversity Strategy and Action Plan
NCD	Noncommunicable diseases
NCR	National Capital Region
n.d.	No data available
NDC	Nationally Determined Contributions
NDRC	National Development and Reform Commission
NEM:AQA	National Environmental Management: Air Quality Act
NGO	Non-governmental organisation
NIUA	National Institute of Urban Affairs
NOx	Nitrogen oxides
NPC	National People's Congress
NPCC	National Plan on Climate Change
NRDWP	National Rural Drinking Water Programme
NUA	New Urban Agenda
NUSP	National Urban Sanitation Policy
NUTP	National Urban Transport Policy
NWRC	National Water Resources Councils
NWRMS	National Water Resource Management System

NWRP	National Water Resources Policy
NWRS	National Water Resource Strategy
ObsMob-BH	Mobility Observatory of Belo Horizonte
OECD	Organisation of Economic Co-operation and Development
ONF	All Russia's People's Front
OPS	Observatório Político Social
PAHO	Pan American Organisation
PanelBio	Panel on Biodiversity
PBMP	Pedestrian and Bicycle Masterplan
PBR	Peoples Biodiversity Register
PDE	Decenal Plan of Energy Expansion
PlanMob-BH	Mobility Master Plan
Plansab	National Basic Sanitation Plan
PM	Particulate matter
PMBC	Low Carbon Emissions Mining Plan
PMGIRS	Municipal Plans for Integrated Management of Solid Waste
PNBP	Biodiesel Production and Use
PNCLM	National Plan to Combat Oceans Pollution
PNRS	National Solid Waste Policy
PNSB	National Basic Sanitation Plan
PPBio	Research Programme on Biodiversity
PPCDAm	Action plan for the prevention and control in the Amazon
PPCerrado	Action Plan for Prevention and Control of Deforestation and Forest Fires in the Cerrado region
PRD	Pearl River Delta
PREGEE	Greenhouse gas emission reduction plan
ProAlcool	Promotion of the Production of Biofuels
Probiodiesel	Biodiesel Programme
PROCONVE	Programme for the Control of Automotive Vehicles Pollution
PRONAR	National Air Quality Programme
PSL	Social Liberal Party of Brazil
PSTM	Sectoral Plan for Transport and Urban Mobility for Climate Change Mitigation
PwC	PricewaterhouseCoopers
RAD-GRK	Regional Action Plan for Greenhouse Gas Emission Reduction

RAN-API	Indonesia National Action Plan on Climate Change Adaption
RAQMC	Regional Air Quality Monitoring Centre
RBC	River Basin Committee
RCD	Recycling of Construction and Demolition Waste Program
RMBH	Metropolitan Region of Belo Horizonte
RPJMN	National Medium Term Development Plan
RTRW	Spatial Plan of Jabodetabekpunjur Area
SA	South Africa
SACN	South African Cities Network
SAMRC	South African Medical Research Council
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAPCC	State Plan on Climate Change
SAWS	South African Weather Service
SBio	Biodiversity Secretariat
SCP	Sponge City Programme
SDG	Sustainable Development Goals
SEEG	Greenhouse Gas Emissions Estimation System
SFB	Brazilian Forest Service
SO2	Sulphur dioxide
SOx	Sulphur oxides
SPATC	Strengthen climate resilience of rural communities
SPI	Standard Pollution Index
SMMA	Municipal Secretariat for the Environment
SNIS-RS	National Sanitation Information System – Solid Waste
SNSA	National Department of Environmental Sanitation
SWP	Solid waste plan
SWRC	State Water Resources Council
SWRI	State Water Resources Management Institution
TERI	The Energy and Resources Institute
TNN	Times News Network
TOD	Transit oriented development
tpd	Tons per day
UAQ-I SDP	Urban Air Quality Improvement Sector Development Program
UBA	German Federal Environmental Agency (UBA)

UHI	Urban heat islands
UITP	Union Internationale des Transports Publics
ULB	Urban local bodies
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNU-IAS	United Nations University Institute for the Advanced Study of Sustainability
USAID	United States Agency for International Development
U.S. EPA	United States Environmental Protection Agency
USW	Urban solid waste
VOC	Volatile organic compounds
WBGU	Advisory Council on Global Change
WA	Water agency
WCWDM	Water conservation and Water Demand Management Strategy
WHO	World Health Organisation
WRI	World Resources Institute
WWF	World Wide Fund for Nature
YRD	Yangtze River Delta

Summary

Objectives and overview

The aim of this study is to contribute to a process of learning about successful approaches to tackle problems and challenges of urban environmental protection. For this purpose, a detailed overview of the importance of environmental challenges, political priorities and successful solutions in selected countries and cities is provided. On this basis, the study analyses factors of success and it examines, to what extent such success factors found in the case studies can be transferred to and replicated in other cities. Finally, recommendations are provided to cities, countries and the international community how to further strengthen environmental protection at the urban level. The role of German cities and institutions is discussed as well.

The study consists of three main parts. In the first part (chapters 3-16), it searches for innovative international approaches. The selected countries under analysis are Brazil, Russia, India, China, South Africa and Indonesia due to their progressing rapid urbanisation processes and their importance for German international cooperation. For this purpose, it gathers information about environmental challenges at the urban level in these selected countries. It analyses, to what extent these are defined as environmental challenges. Moreover, it assesses national political priorities to resolve a certain challenge of urban environmental protection. The analysis of priorities in these countries and their approaches to resolve these issues justify a discussion about potential fields of activity of international collaboration.

In the second part of this study (chapters 17-22), six cities, including Belo Horizonte in Brazil, Moscow in Russia, Kochi in India, Beijing in China, Cape Town in South Africa and Jakarta in Indonesia, are analysed. The cities' challenges to protect the environment and their political priorities reflect to a large extent the national challenges and priorities. This enables us to analyse the influence of national political priorities on urban policy making and success factors (final part of the study, see below). For each of the six cities, two spotlights describing ambitious interventions are described. The aim is to find successful plans, policies, instruments, measures and other activities to tackle challenges of urban environmental protection. Local factors that influence the success of these activities are identified.

In the final part (chapters 23-25), this study identifies successful approaches and their reasons. It determines factors of success in the six countries. The success factors can be both a consequence of local efforts and a consequence of sensible coordination and allocation of responsibilities of the respective country's policy levels. Moreover, potentials for replication and transferability are identified. On this basis, the study provides recommendations for cities, countries and the international community how successful urban environmental protection can be fostered. The role of German cities and institutions is discussed as well.

National and local environmental challenges and political priorities

The national and local environmental challenges and political priorities differ among the selected countries and respective cities (and for the case of Brazil also between the national and the local level) due to the heterogeneity regarding their environmental and socio-economic background as well as their political and institutional framework.

Brazil/Belo Horizonte

There is no uniform trend in the significance of Brazil´s fields of activities with regard to their identification, definition and political implementation. Since decades, Brazil identifies various highly significant environmental challenges, including social inclusion, climate change mitigation, land sealing and soil degradation, air pollution and sustainable mobility. The

government creates the regulatory frameworks to face these challenges and does significant progress in its implementation. Similarly, waste management, public health and water pollution are considered as relevant challenges. On the other hand, adaptation to climate change as well as the loss of biodiversity, are regarded as rather insignificant challenges for the time being. Finally, waste management is a field with strong awareness of problems and challenges among all stakeholders, however, actual political implementation is lacking behind.

On a local scale, Belo Horizonte has a series of plans and policies in place that are reviewed and monitored on a regular basis to help guiding the urban development of the city. As such, the city has already made important progress towards sustainability in the medium and long run. The most relevant policies include the Environmental Law of Belo Horizonte of 1985, Municipal Policy for Mitigation of the Effects of Climate Change in 2011, the Master Plan of 2009, The BH 2030 Strategic Plan in 2009 and the Strategic Programme "Belo Horizonte – a Smart City" in 2018. Belo Horizonte shows that challenges which are identified as significant on a national scale can be successfully translated to the urban strategies. This becomes particularly evident when examining the two spotlights, namely climate change mitigation and sustainable mobility (to tackle both climate change and air pollution). Both fields are highly relevant for both the city and the national level. Both fields show significant progress.

It is important to note that on the national level, populistic politicians were sworn into office in recent years. Interestingly, the local administration in Belo Horizonte (a prosperous city) still maintains efforts to protect the urban environment despite significant budget cuts. This can be explained with long-term national and local efforts and with well-trained local staff. However, long term implications are yet unclear.

Russia/Moscow

On a national scale, air pollution, waste generation, land sealing and soil degradation, water pollution and green public spaces as well as the loss of biodiversity are defined as significant environmental challenges. Less significant for many stakeholders are the areas of climate change adaptation/mitigation and noise pollution. In some fields, actual implementation diverges substantially from problem identification, namely loss of biodiversity, land sealing and soil degradation. For other areas, such as air pollution and waste management, the significance of the identification of the challenges coincides well with the significance of political measures.

The comparison of political priorities on the Russian national and the local level in Moscow reveals that top national priorities are mainly replicated on the local level. What is more, the Moscow city administration sets its own priorities. Over the last years the city has been implementing ambitious environmental protection policies. This comes as a consequence to a number of challenges, among them air and noise pollution and resource efficiency. Another reason appears to be increasing environmental awareness in Russia, and in Moscow in particular. Moscow has been modernizing its air monitoring system, wastewater treatment facilities, introducing new regulation of vehicle and fuel standards, realizing a number of tree-planting programs in the city, reforming road infrastructure, developing climate adaptation plans. Over the last 10-15 years the city has also made significant progress in the area of energy and water efficiency. In particular, Moscow has put considerable efforts in combatting air pollution and promoting sustainable mobility in the city.

India/Kochi

In the context of a rapidly increasing population in India, air and water pollution, climate change mitigation as well as waste generation, public health, water pollution, land sealing and land degradation and the adoption to climate change are defined as very significant environmental

challenges. For most fields of activity, India shows a positive trend of identifying urban environmental challenges as well as achieving their implementation; for the field of land sealing and soil degradation, however, India does not traverse the identification phase and does not introduce binding targets into its political agenda.

The city of Kochi has been taking actions to protect the urban environment by developing and implementing policies and measures. As an initiative of the State planning Board, Kochi has released Kerala Perspective Plan 2030, in 2015, with a long-term development strategy. The perspective plan aims to make the state a prosperous, knowledge-driven, competitive and eco-efficient economy. The vision for environmental sustainability includes: upgrade ecosystems, biodiversity and resources through sustainable production systems and consumption; protect wetlands; conserve the World Heritage biodiversity of the Western Ghats; increase energy efficiency to save 10 per cent of Kerala's energy and water consumption by 2030; recycle between 60 and 75 per cent of waste generated; and identify and maximize the use of sustainable resources. The Kerala state pollution Board (KSPCB) is also carrying out cross-sectoral actions to tackle environmental challenges in Kochi. The city puts substantial efforts in the combat of air pollution and the improvement of solid waste management.

China/Beijing

For China, climate change mitigation and adaption, air and water pollution, waste generation, land sealing, soil degradation/pollution and public health are identified as environmental challenges at a national scale. For all identified fields, China introduced binding targets into its political agenda.

Beijing city has progressively taken sectoral and cross-sectoral actions on environmental protection. In particular, air pollution reduction and improvements in water management are promoted and encouraged by the municipality. Similarly to the national government, every five years, municipal governments issue Five-Year Plans (FYPs) of overall economic and social development as well as specific fields such as environmental protection, climate action, energy efficiency, and energy supply. The 13th environmental protection FYP (2016-2020) of Beijing sets targets for water, air and soil protection as well as solid wastes and specifies measures in different sectors to achieve these targets. To achieve both energy efficiency and renewable goals, the building, transport, industry and energy sector have received high attention. To promote cross-sectoral collaboration, the municipal government established an air pollution prevention and control leading group led by the mayor.

South Africa/ Cape Town

South Africa has not only identified many of the challenges for the protection of urban environment, but also increasingly introduces targets and corresponding policies. Climate change mitigation, air pollution, resource protection and urban mining, water pollution and waste generation, public health, the loss of biodiversity, land sealing and soil degradation/pollution are perceived as environmental challenges in South Africa. South Africa introduced binding targets for the fields of climate mitigation, air pollution, sustainable mobility, public health as well as water pollution. Non-binding targets were introduced for biodiversity loss, waste management as well as land sealing and soil degradation.

The City of Cape Town has sought to be proactive in addressing issues of environmental protection. In 2001, Cape Town becomes the first city in Africa to approve and adopt a comprehensive city-wide environmental policy: The Integrated Metropolitan Environmental Policy (IMEP). The IMEP sets out the city's environmental commitments and the policy is accompanied by a series of strategies and plans that outline specific steps for achieving sectoral

goals. Since 2014, Cape Town has actively worked towards the city's designation as the first metro bioregion in South Africa. For this purpose, the city has set up the Cape Town Bioregional Plan which is a spatial plan that showcases terrestrial and aquatic features that are critical for conserving biodiversity and maintaining ecological functioning. The City is making a concerted effort to improve its resource efficiency, as well as to address factors that affect climate change. This includes climate change mitigation, improvement of air quality, the diversification of its energy mix, as well as adaptation measures such as conserving biodiversity, reducing waste to landfill, and increasing recycling. In this regard, the city has developed an „energy2040" vision and set energy goals and targets for 2020 for the residential sector, commerce, transport as well as energy generation.

Air pollution reduction and water management form substantial and relevant policy fields, where measures have successfully been implemented. An important reason for the implementation of far-reaching policies and measures in these two fields is the sheer pressure to act: Air pollution and water scarcity in the Cape region are a threat for inhabitants and ecosystem.

Indonesia/Jakarta

For Indonesia, national environmental challenges include climate change mitigation, air pollution, sustainable mobility, waste generation and water pollution and to some extent also land sealing, soil degradation, resource protection and urban mining as well as green public spaces. However, there is no clear trend in Indonesia´s strategy of identifying urban environmental challenges and consequently introducing (non)binding political targets. Accordingly, the significant identification of environmental issues does not necessarily point to the introduction of binding political targets.

Jakarta has progressively developed various sectoral and cross-sectoral policies with respect to urban environmental protection. These include instruments for emission reduction, resource efficiency, air quality improvement, waste management and sustainable urban planning (e.g. alternative mobility options such as a rapid bus transit system). Efforts to protect the urban environment have been developed since 1965 in the form of Master-Plans, which are revised every five years, or most recently, in the form of the Green Building Code, which is a legally binding instrument covering the fields of energy-, water-, and material efficiency as well as waste management and urban green zoning. Combatting climate change as well as waste management rank high on the city's political priorities and represent successful approaches in promoting sustainable urban environmental protection.

Factors of success and transferability

Brazil/Belo Horizonte

Brazil has a long history of work towards environmental protection. Environmental policies and the associated institutions have, however, undergone several changes under Jair Bolsonaro's administration (2019 – present), reducing significantly their power and capacities to formulate and implement policies, including the establishment of environmental standards and guidelines. The impact of Bolsonaro's political agenda for facing the urban environmental challenges in Brazilian cities is still unknown. Nevertheless, the fact that the national government has put the environment law in its priorities' list has given the local governments the responsibility and the necessary scope to strengthen measures of urban environmental protection. In that context, it is possible to identify a clear difference in political priorities between the national and the local levels. Belo Horizonte is a good example for this.

Compared to the national political framework, Belo Horizonte benefits from a longstanding institutionalisation process of environmental policies in Brazil. It has a similar set of long-term strategies, master plans and laws in place and the technical staff to push the processes forward despite changes in the political agenda. The international partnerships built over the years increase the stability of the commitment. A further factor of success is the local administration's capacity and a clear institutional framework that facilitates working on an independent local political agenda.

Despite the downturn of environmental policies since the introduction of Jair Messias Bolsonaro's mandate, Belo Horizonte's environmental policies have the potential of replication elsewhere in the country. The city shows that its environmental policies are based on an effective multi-level governance system which allows a bottom-up instead of a top-down approach.

Russia/Moscow

On the federal level the topic of environmental protection in cities is currently defined by a number of legislation acts, and two overarching national projects (these are strategic development programs for particular areas and specific national goals for 2030) - the national project "Environment" and the national project "Housing and Urban Environment". Still, on the federal and more often on the regional levels, many elements of environmental and urban strategies, policy implementations and planning are often ill-connected with each other and they lack a holistic and cross-sectoral approach, that brings all elements of urban infrastructure into one sustainable and resilient system.

The comparison of political priorities on the Russian national and the local level in Moscow reveals that top national priorities are mainly replicated on the local level. However, Moscow also sets its own priorities. In some cases, the local ambition reaches further than the national, namely with respect to climate change and its effects, urban green space and noise pollution. A likely reason is the status of Moscow (and the whole region) as biggest and richest city of the Russian Federation. Other factors of success include the selection of political instruments, such as clear process targets, stakeholder commitment, monitoring of compliance, fiscal incentives and transparency and accountability of city administrations.

The replication of Moscow's environmental approach in other Russian cities is facilitated if urban environmental protection is prioritized similarly at a national, regional and local level. In that case, top-down policies incentivize knowledge transfer and facilitates governmental funding from the national to the regional and local level. For a successful replication, environmental approaches are, however, in need of a more holistic and comprehensive multi-level coordination and communication of environmental cross-sectional activities at all involved governmental levels.

India/Kochi

The success in India results from joint efforts of many different institutions on different policy levels as well as the combination of central top-down policies and bottom-up approaches. The most pressing urban environmental challenges in India, such as climate change mitigation and adaptation, air pollution, water pollution and waste generation, have been addressed at national, state as well as city level through regulatory framework and supportive policies and actions. The environmental challenges and responding measures vary according to the cities in India.

The selected case in Kochi shows that the city has been highly active in various urban development programs and activities to protect the urban environment, mainly to tackle air pollution and waste generation. The local government of Kochi plays a key role to carry out the

climate actions and to enable factors for supportive state-level actions and policies, including financial assistance, responsive local communities, monitoring of activities, as well as international and inter-city collaboration.

The case study of Kochi proves that a successful approach in combatting environmental challenges hinges on the effective communication, coordination and development of strategies of interrelated and multi-level governmental institutions. Hence, a replication can be assumed to be facilitated when the replicating city aligns, similarly to Kochi, top-down policies with bottom-up approaches in terms of supportive roles and responsibilities.

China/Beijing

The environmental governance structure in China exhibits a complex and mixed nature. On the one hand, given the hierarchical structure in China, policies are implemented in a top-down manner, i.e. from the responsible ministry reaching down to its line offices at different administrative levels, including municipal bureaus. On the other hand, municipal governments have a large degree of decision-making autonomy of local development and sometimes selectively implement national environmental policies, considering their local needs.

The case study of Beijing shows that the dual structure of China's environmental policy can be highly successful due to a strict implementation from the top national level down to the local level. Overall, the success lies in the governance structure, i.e. the combination of vertical and horizontal integration (cross-sectoral and cross regions). In addition, an effective policy package as well as economic and human resources of the capital region play a significant role. Another key factor of Beijing's successful implementation of environmental policies, in particular with regard to air and water quality, is the comprehensive policy package covering different key sectors. This includes specific targets and overarching strategies (e.g. Five-year Clean Air Action Plan), specific local legislation, command-and-control measures, market-based instruments, environmental standards, financial incentives and public access to information.

Hence, Beijing has the economic and human resources to identify and combat environmental challenges efficiently; however, other cities may not have a comparable prosperous and geographic conditions; this replication may be more complicated and may require the provision of additional funding.

South Africa/Cape Town

South Africa's success in addressing environmental challenges can be attributed to its cooperative governance approach. Environmental authorities at the national, provincial and local level are in charge of identifying, defining and addressing environmental problems by implementing the corresponding policies. Considerable decision-making authority is transferred to the provincial and to the local level. Thus, a part of the success in Cape Town can be explained with the principle of subsidiarity.

Policies in Cape Town are set on key principles including public participation, ensuring the public acceptance of national as well as local environmental policies in the city, as well as on monitoring and enforcement strategies, financial incentives, public access to information and public awareness, and the minimisation of environmental challenges at the source. Another part of success in South Africa is the sheer pressure to be active. South Africa and particularly the cape region belong to the world´s most biologically diverse areas. At the same time, water is a scarce resource in South Africa, which is particularly the case for Cape Town. South Africa's capital is, hence, an example of how top-down as well as bottom-up policies are efficiently implemented in the country's national, regional and local environmental policy agenda and how they contribute to a mutual learning process of the different governance levels.

A successful replication of Cape Town's environmental approach is, hence, facilitated by an effective cooperation between the different governmental institutions. Based on that, institutions and stakeholders at different governance levels must be given the possibility to profit from a shared vertical as well as horizontal learning process, which facilitates the application of both top-down as well as bottom-up policies at different locations. Furthermore, Cape Town's success story is a result of available investment flows and financial resources that facilitate the implementation of ambitious approaches.

Indonesia/Jakarta

Indonesia has made a strong push towards political, administrative, and fiscal decentralisation, giving regional and local political levels much more economic and political autonomy than under the former Suharto regime. As a result, the number of provincial and local regulations and policies has increased. In recent years, there has been, however, a trend back towards the partial centralisation of political powers. As a result, environmental policies in several fields are defined by top-down regulation. This has created a complex web of governance, which sometimes creates unclear decision-making power hold.

Jakarta has progressively developed various sectoral and cross-sectoral policies for urban environmental protection. These include instruments for emission reduction, resource efficiency, air quality improvement, waste management, and sustainable urban planning. Jakarta's factors of success include a supportive local government with the vision to develop Jakarta as a smart city, responsive local government representatives, community action plan programs, opportunities for private investments in public services, data collection and monitoring activities as well as international collaboration.

Due to Indonesia's recent trend back towards the centralisation of political powers, creating a complex web of governance, a clear definition of decision-making authority can be assumed to facilitate the replication of a city's successful environmental policy approach.

Recommendations

The cases which are presented in this study are from big cities and metropolitan regions in six selected countries. According to the case studies, the main challenges are air pollution, climate change and its effects, land sealing/land degradation/desertification, waste management and water management. Those challenges are well known in countries and cities all over the world. The ability to act of the countries and respective cities in this study results to a large extent from massive financial and human resources, investments into technical capabilities and the political willingness of the respective authorities. However, there are other factors of success, and, more importantly, other ways to finance sustainable urban development and capacity building. The study found similar patterns of success factors which could be applied not only to tackle traditional challenges to protect the urban environment, but also new and emerging problems.

Pattern 1 – enforcement of local targets through national regulation: Environmental protection at the urban level may begin with a certain set of targets, which are defined by the national level, but have to be implemented by the decision makers at the urban level. Such targets may be technical standards or environmental standards, which leave the process/means to accomplish the targets open to the local level.

Pattern 2 – monetary incentives: A common national strategy to foster environmental protection at the local level is to provide monetary support, which is provided based on certain conditions to achieve certain process targets. Such targets may be numbers of devices/equipment used, manpower or a predefined quality levels for techniques to be used to protect the environment at the local level.

Pattern 3 – facilitation of local ambition through national directives: Local action can be initiated at the national level by setting enabling frameworks. This may include indicative targets and declarations of intent. Such directives usually determine responsibilities for tasks and demand certain legal forms for businesses and partnerships.

Germany faces other challenges than fast growing megacities in emerging economies. However, the international cases have shown that some basic principles of urban environmental protection prove to be successful:

- The subsidiarity principle
- Sufficient human and financial resources
- Cross-sectoral plans and strategies for the long-term horizon, complemented with sectoral policies and measures
- Comprehensive data, monitoring
- Compliance and enforcement mechanisms
- A mix of command-and-control and market-based policies
- Cooperation of the public sector with civil society

As research and practical experience in Germany is well advanced in several fields of activity, German institutions should also contribute to resolving new and emerging urban sustainability challenges worldwide. For instance, noise pollution, walkable green and blue infrastructure, or circular economy are relatively new in many countries, whereas German public institutions can already draw upon experience in such areas.

In general, the international community should further seek to strengthen the knowledge base and build capacity how to protect the environment at the urban level, promoting peer exchange, city-to-city and city-to-region connections worldwide. The UN, multi- and bilateral international cooperation and city networks should build thematic bubbles with cities facing similar challenges to guarantee long-term stability of policies. Moreover, cities with similar challenges working in thematic groups can also push for robust policies at the national level that reflect the interests of local and regional governments and apply global policy to sustainable urban development strategies at the subnational level.

Zusammenfassung

Zielsetzung und Überblick

Das Ziel dieser Studie ist es, zu einem Lernprozess über erfolgreiche Ansätze zur Bewältigung von Problemen und Herausforderungen des städtischen Umweltschutzes beizutragen. Zu diesem Zweck wird ein detaillierter Überblick über die Bedeutung von Umweltherausforderungen, politischen Prioritäten und erfolgreichen Lösungen in ausgewählten Ländern und Städten gegeben. Darauf aufbauend analysiert die Studie Erfolgsfaktoren und diskutiert, inwieweit diese auf andere Städte übertragen und repliziert werden können. Abschließend werden Empfehlungen an Städte, Länder und die internationale Gemeinschaft gegeben, wie der Umweltschutz auf städtischer Ebene weiter gestärkt werden kann. Auch die Rolle der deutschen Städte und Institutionen wird diskutiert.

Die Studie besteht aus drei Hauptteilen. Im ersten Teil (Kapitel 3-16) werden innovative internationale Ansätze erörtert. Als Fallstudien wurden sechs Länder, einschließlich Brasilien, Russland, Indien, China, Südafrika und Indonesien, aufgrund ihrer fortschreitenden schnellen Urbanisierungsprozesse und ihrer Bedeutung für die deutsche Zusammenarbeit ausgewählt. Für die Analyse werden Informationen über umweltpolitische Herausforderungen auf städtischer Ebene in den genannten Ländern gesammelt. Es wird analysiert, inwieweit Umweltherausforderungen als solche definiert sind. Darüber hinaus werden die nationalen politischen Prioritäten zur Lösung bestimmter Herausforderungen hinsichtlich des städtischen Umweltschutzes bewertet. Die Analyse der Prioritäten in diesen Ländern und deren Lösungsansätze ermöglichen eine Diskussion über mögliche Handlungsfelder der internationalen Zusammenarbeit.

Im zweiten Teil dieser Studie (Kapitel 17-22) werden sechs Städte, nämlich Belo Horizonte in Brasilien, Moskau in Russland, Kochi in Indien, Peking in China, Kapstadt in Südafrika und Jakarta in Indonesien, analysiert. Dies ermöglicht es, den Einfluss der nationalen politischen Prioritäten auf die städtische Politikgestaltung und die Erfolgsfaktoren (letzter Teil der Studie, siehe unten) zu analysieren. Für jede der sechs Städte werden zwei Spotlights mit jeweils ambitionierten Interventionsmaßnahmen beschrieben. Ziel ist es, erfolgreiche Pläne, Politiken, Instrumente, Maßnahmen und andere Aktivitäten zur Bewältigung der Herausforderungen des städtischen Umweltschutzes zu erörtern. Es werden lokale Faktoren identifiziert, die den Erfolg dieser Aktivitäten beeinflussen.

Im letzten Teil (Kapitel 23-25) identifiziert diese Studie erfolgreiche Ansätze und deren Gründe. Sie ermittelt Erfolgsfaktoren in den sechs Ländern. Die Erfolgsfaktoren können sowohl eine Folge lokaler Bemühungen als auch eine Folge einer effektiven Koordination und Verantwortungszuweisung der jeweiligen politischen Ebenen des Landes sein. Darüber hinaus wird das Potenzial zur Replikation und Übertragbarkeit identifiziert. Auf dieser Grundlage gibt die Studie Empfehlungen für Städte, Länder und die internationale Gemeinschaft, wie erfolgreicher städtischer Umweltschutz gefördert werden kann. Auch die Rolle der deutschen Städte und Institutionen wird diskutiert.

Nationale und lokale Umweltherausforderungen und politische Prioritäten

Die nationalen und lokalen Umweltherausforderungen und politischen Prioritäten unterscheiden sich zwischen den ausgewählten Ländern und den jeweiligen Städten (in Brasilien auch innerhalb des Landes zwischen nationaler und lokaler Ebene) aufgrund der Heterogenität in Bezug auf ihren ökologischen und sozioökonomischen Hintergrund sowie die politischen und institutionellen Rahmenbedingungen.

Brasilien/Belo Horizonte

Es gibt keinen einheitlichen Trend in der Identifikation, Definition und politischen Umsetzung der brasilianischen Handlungsfelder hinsichtlich des urbanen Umweltschutzes. Seit Jahrzenten lässt Brasilien verschiedenen Umweltherausforderungen, darunter soziale Inklusion, Klimaschutz, Flächenversiegelung und Bodendegradation, Luftverschmutzung und nachhaltige Mobilität höchste Bedeutung zukommen. Die Regierung schafft die rechtlichen Rahmenbedingungen und macht erhebliche Fortschritte bei der Umsetzung. Auch die Abfallwirtschaft, die öffentliche Gesundheit und die Wasserverschmutzung werden als relevante Herausforderungen angesehen. Andererseits werden die Anpassung an den Klimawandel sowie der Verlust der Artenvielfalt derzeit als eher unbedeutende Herausforderungen angesehen. Hinsichtlich der Abfallwirtschaft herrscht ein starkes Problembewusstsein, die tatsächliche politische Umsetzung steht jedoch noch aus.

Auf lokaler Ebene verfügt Belo Horizonte über eine Reihe von Plänen und Richtlinien, die regelmäßig überprüft und überwacht werden, um die Stadtentwicklung zu steuern. Die Stadt hat bereits wichtige Fortschritte in Richtung Nachhaltigkeit auf mittel- und langfristige Sicht gemacht. Zu den wichtigsten Richtlinien gehören das Umweltgesetz von Belo Horizonte aus dem Jahr 1985, die städtische Politik zur Minderung der Auswirkungen des Klimawandels aus dem Jahr 2011, der Masterplan aus dem Jahr 2009, der Strategieplan BH 2030 aus dem Jahr 2009 und das Strategieprogramm "Belo Horizonte – a smart city" aus dem Jahr 2018. Belo Horizonte zeigt, dass Herausforderungen, die auf nationaler Ebene als relevant angesehen werden, erfolgreich auf die städtischen Strategien übertragen werden können. Dies wird besonders deutlich, wenn man die beiden vorgestellten Spotlights betrachtet, nämlich Klimaschutz und nachhaltige Mobilität (um sowohl dem Klimawandel als auch der Luftverschmutzung entgegenzuwirken). Beide Felder sind sowohl für die städtische als auch für die nationale Ebene von hoher Relevanz. Beide Felder zeigen signifikante Fortschritte.

Es ist wichtig zu beachten, dass auf der nationalen Ebene in den vergangenen Jahren populistische Politiker ins Amt gewählt wurden. Interessanterweise hält die lokale Verwaltung in Belo Horizonte (einer ressourcenreichen Stadt) trotz erheblicher Budgetkürzungen an ihren Bemühungen zum städtischen Umweltschutz fest. Dies lässt sich mit der Langfristigkeit, mit der nationale und lokale Strategien festgelegt wurden, sowie mit dem technischen Know-how und der Expertise lokaler Institutionen erklären. Langfristige Auswirkungen sind jedoch noch unklar.

Russland/Moskau

Auf nationaler Ebene werden Luftverschmutzung, Abfallaufkommen, Flächenversiegelung und Bodendegradation, Wasserverschmutzung und öffentliche Grünflächen sowie der Verlust der biologischen Vielfalt als bedeutende Umweltherausforderungen definiert. Weniger bedeutend sind für viele Akteure die Bereiche Anpassung/Minderung des Klimawandels und Lärmbelastung. In einigen Bereichen weicht die tatsächliche Umsetzung erheblich von der Problemerkennung ab, wie zum Beispiel beim Verlust der biologischen Vielfalt, der Flächenversiegelung und der Bodendegradation. Bei anderen Bereichen, wie Luftverschmutzung und Abfallwirtschaft, deckt sich die Relevanz, mit der Herausforderungen definiert werden, mit der Relevanz der politischen Maßnahmen.

Der Vergleich der politischen Prioritäten auf nationaler und lokaler Ebene in Moskau zeigt, dass die nationalen Prioritäten, denen höchste Bedeutung zugemessen wird, auch auf lokaler Ebene repliziert werden. Darüber hinaus setzt die Moskauer Stadtverwaltung ihre eigenen Prioritäten. Während der letzten Jahre hat die Stadt eine ambitionierte Umweltschutzpolitik umgesetzt. Dies ist eine Folge aus einer Reihe von Herausforderungen, darunter Luft- und Lärmbelastung sowie Ressourceneffizienz. Ein weiterer Grund scheint das wachsende Umweltbewusstsein in Russland und insbesondere in Moskau zu sein. Moskau hat sein Luftüberwachungssystem und

seine Abwasseraufbereitungsanlagen modernisiert, neue Regelungen für Fahrzeug- und Kraftstoffstandards eingeführt, eine Reihe von Baumpflanzungsprogrammen in der Stadt durchgeführt, die Straßeninfrastruktur reformiert und Pläne zur Klimaanpassung entwickelt. In den letzten 10-15 Jahren hat die Stadt auch erhebliche Fortschritte im Bereich der Energie- und Wassereffizienz gemacht. Insbesondere hat Moskau erhebliche Anstrengungen zur Bekämpfung der Luftverschmutzung und zur Förderung einer nachhaltigen Mobilität in der Stadt unternommen.

Indien/Kochi

Im Kontext einer schnell wachsenden Bevölkerung in Indien werden Luft- und Wasserverschmutzung, Klimaschutz, Abfallerzeugung, öffentliche Gesundheit, Wasserverschmutzung, Flächenversiegelung und Bodendegradation sowie die Anpassung an den Klimawandel als sehr relevante Umweltherausforderungen definiert. Für die meisten Handlungsfelder zeigt Indien einen positiven Trend bei der Identifizierung von städtischen Umweltherausforderungen sowie bei der Umsetzung von Gegenmaßnahmen; für den Bereich der Flächenversiegelung und Bodendegradation kommt Indien jedoch nicht über die Identifizierungsphase hinaus und nimmt keine verbindlichen Ziele in die politische Agenda auf.

Die Stadt Kochi hat Maßnahmen zum Schutz der städtischen Umwelt ergriffen, indem sie Politiken und Maßnahmen entwickelt und umgesetzt hat. Auf Initiative der staatlichen Planungsbehörde hat Kochi den Kerala Perspective Plan 2030 entworfen, der 2015 veröffentlicht wurde und eine langfristige Entwicklungsstrategie enthält. Dieser soll den Bundesstaat zu einem wohlhabenden, wissensbasierten, wettbewerbsfähigen und ökoeffizienten Wirtschaftsraum machen. Die Vision für ökologische Nachhaltigkeit umfasst: die Aufwertung von Ökosystemen, Biodiversität und Ressourcen durch nachhaltige Produktionssysteme und Konsum; den Schutz von Feuchtbiotopen; die Erhaltung der Biodiversität des Weltnaturerbes der Western Ghats; die Steigerung der Energieeffizienz, um bis 2030 10 Prozent des Energie- und Wasserverbrauchs in Kerala einzusparen; das Recycling von 60 bis 75 Prozent des anfallenden Abfalls; sowie die Identifizierung und Maximierung der Nutzung nachhaltiger Ressourcen. Das Kerala State Pollution Board (KSPCB) führt ebenfalls sektorübergreifende Maßnahmen durch, um die ökologischen Herausforderungen in Kochi zu bewältigen. Die Stadt unternimmt erhebliche Anstrengungen im Kampf gegen die Luftverschmutzung und zur Verbesserung der Abfallwirtschaft.

China/Peking

Für China wurden auf nationaler Ebene die Minderung und die Anpassung an den Klimawandel, die Luft- und Wasserverschmutzung, das Abfallaufkommen, die Flächenversiegelung, die Bodendegradation/-verschmutzung und die öffentliche Gesundheit als ökologische Herausforderungen identifiziert. Für alle identifizierten Bereiche hat China verbindliche Ziele in die politische Agenda aufgenommen.

Die Stadt Peking hat schrittweise sektorale und sektorübergreifende Maßnahmen zum Umweltschutz ergriffen. Insbesondere die Reduzierung der Luftverschmutzung und Verbesserungen im Wassermanagement werden von der Stadtverwaltung gefördert und unterstützt. Ähnlich wie die nationale Regierung entwickeln die chinesischen Stadtregierungen regelmäßig Fünfjahrespläne (FYPs), um die allgemeine wirtschaftliche und soziale Entwicklung sowie spezifische Bereiche wie Umweltschutz, Klimaschutz, Energieeffizienz und Energieversorgung zu fördern. Der 13. Umweltschutz-FYP (2016-2020) von Peking setzt Ziele für den Schutz von Wasser, Luft, Boden und Abfall und legt Maßnahmen in den jeweiligen Sektoren fest, um diese Ziele zu erreichen. Um sowohl die Ziele für Energieeffizienz als auch für erneuerbare Energien zu erreichen, wurde insbesondere dem Gebäude-, Transport-, Industrie-

und Energiesektor große Bedeutung zugemessen. Um die sektorübergreifende Zusammenarbeit zu fördern, hat die Stadtverwaltung einen Verbund zur Vermeidung und Kontrolle der Luftverschmutzung unter der Leitung des Bürgermeisters eingerichtet.

Südafrika/Kapstadt

Südafrika hat nicht nur viele der aufkommenden Herausforderungen für den städtischen Umweltschutz identifiziert, sondern führt auch zunehmend Ziele und entsprechende Maßnahmen ein. Klimaschutz, Luftverschmutzung, Ressourcenschutz und Urban Mining, Wasserverschmutzung und Abfallaufkommen, öffentliche Gesundheit, der Verlust von Biodiversität, Landversiegelung und Bodendegradation/-verschmutzung werden in Südafrika als ökologische Herausforderungen wahrgenommen. Verbindliche Ziele wurden für die Bereiche Klimaschutz, Luftverschmutzung, nachhaltige Mobilität, öffentliche Gesundheit sowie Wasserverschmutzung festgelegt. Unverbindliche Ziele wurden für den Verlust der biologischen Vielfalt, das Abfallmanagement sowie die Flächenversiegelung und Bodendegradation formuliert.

Kapstadt hat sich an Fragen des Umweltschutzes proaktiv herangetastet. Im Jahr 2001 verabschiedet Kapstadt als erste Stadt in Afrika eine umfassende stadtweite Umweltpolitik: die Integrated Metropolitan Environmental Policy (IMEP). Die IMEP legt die Umweltverpflichtungen der Stadt fest, begleitet von einer Reihe von Strategien und Plänen, die spezifische Schritte zur Erreichung sektoraler Ziele skizzieren. Seit 2014 arbeitet Kapstadt aktiv auf die Ernennung der Stadt zur ersten Metro-Bioregion Südafrikas hin. Letzteres soll durch einen räumlichen Entwicklungsplan erzielt werden, der Indikatoren für Land- und Wasserflächen aufzeigt, die für den Erhalt der Biodiversität und der Ökologie entscheidend sind. Die Stadt unternimmt konkrete Anstrengungen, um ihre Ressourceneffizienz zu verbessern und die Faktoren, die den Klimawandel beeinflussen, anzugehen. Dazu gehören die Abschwächung des Klimawandels, die Verbesserung der Luftqualität, die Diversifizierung der Energiequellen sowie Anpassungsmaßnahmen wie zum Beispiel die Erhaltung der Biodiversität, die Verringerung der Abfallmenge auf Deponien und die Steigerung des Recyclings. In diesem Zusammenhang hat die Stadt eine "energy2040"-Vision entwickelt und Energieziele und -vorgaben für 2020 für den Wohnbereich, den Handel, den Verkehr sowie die Energieerzeugung festgelegt.

Die Reduzierung der Luftverschmutzung und die Wasserwirtschaft bilden wesentliche und relevante Politikfelder, in denen Maßnahmen erfolgreich umgesetzt wurden. Ein wichtiger Grund für die erfolgreiche Umsetzung in diesen beiden Bereichen ist der schiere Handlungsdruck: Luftverschmutzung und Wasserknappheit in der Region ist eine Bedrohung für die Bevölkerung sowie für das Ökosystem.

Indonesien/Jakarta

Für Indonesien gehören zu den nationalen Umweltherausforderungen der Klimaschutz, die Luftverschmutzung, die nachhaltige Mobilität, das Abfallaufkommen und die Wasserverschmutzung. Auch die Flächenversiegelung, die Bodendegradation, der Ressourcenschutz, Urban Mining sowie der Schutz öffentlicher Grünflächen werden als Herausforderungen definiert. Es gibt jedoch keinen eindeutigen Trend in Indonesiens Strategie, städtische Umweltherausforderungen zu identifizieren und in der Folge politische Ziele zu setzen, was unter anderem darauf hindeutet, dass auch die Identifizierung von relevanten Umweltthemen nur bedingt zur Formulierung verbindlicher politischer Ziele führt.

Jakarta hat nach und nach verschiedene sektorale und sektorübergreifende Politiken im Hinblick auf den städtischen Umweltschutz entwickelt. Dazu gehören Instrumente zur Emissionsreduzierung, Ressourceneffizienz, Verbesserung der Luftqualität, Abfallmanagement

und nachhaltige Stadtplanung. Bemühungen zum Schutz der städtischen Umwelt werden seit 1965 in Form von Masterplänen entwickelt, die alle fünf Jahre überarbeitet werden – wie zum Beispiel der Green Building Code, der als rechtsverbindliches Instrument die Bereiche Energie-, Wasser- und Materialeffizienz sowie Abfallmanagement und städtische Grünzonierung abdeckt. Die Bekämpfung des Klimawandels sowie die Abfallwirtschaft haben hohe Priorität auf der politischen Agenda der Stadt und stellen erfolgreiche Ansätze zur Förderung eines nachhaltigen städtischen Umweltschutzes dar.

Erfolgsfaktoren und Übertragbarkeit

Brasilien/Belo Horizonte

Umweltschutz spielt in Brasilien seit langem eine wichtige Rolle. Die Umweltpolitik und die damit verbundenen Institutionen haben sich jedoch unter der Regierung von Jair Bolsonaro (2019 - heute) hinsichtlich ihrer Einflussnahme und ihrer Kapazitäten zur Identifizierung und Umsetzung von Maßnahmen, einschließlich der Festlegung von Umweltstandards und -richtlinien, stark verändert. Die Auswirkungen von Bolsonaros politischer Agenda auf die Bewältigung der städtischen Umweltherausforderungen in Brasilien sind noch unbekannt. Nichtsdestotrotz hat das Umweltgesetz, das durch die brasilianische Regierung vor Jahrzenten auf die politische Agenda gesetzt wurde, den lokalen Regierungen die Verantwortung und den entscheidenden Spielraum übertragen, die es ihnen ermöglicht, urbane Umweltschutzmaßnahmen auch weiterhin zu stärken. Darauf ist es zu begründen, dass heute ein deutlicher Unterschied zwischen den politischen Prioritäten der nationalen und der lokalen Politik bezüglich des Umweltschutzes erkennbar ist. Belo Horizonte ist dafür ein gutes Beispiel.

Im Vergleich zum nationalen politischen Rahmen profitiert Belo Horizonte von einem langjährigen Institutionalisierungsprozess der Umweltpolitik in Brasilien. Es verfügt über eine Reihe von langfristigen Strategien, Masterplänen und Gesetzen sowie über das technische Know-how, um den urbanen Umweltschutz trotz Veränderungen in der nationalen politischen Agenda voranzutreiben. Die über die Jahre aufgebauten internationalen Partnerschaften erhöhen die Stabilität des Engagements. Ein weiterer Erfolgsfaktor ist das Know-how und die fachliche Expertise der lokalen Verwaltung sowie ein klarer institutioneller Rahmen, der es ermöglicht, an einer unabhängigen lokalen politischen Agenda zu arbeiten.

Trotz der grundlegenden Veränderung in der Umweltpolitik unter Jair Messias Bolsonaro haben die Maßnahmen, die im urbanen Umweltschutz in Belo Horizonte eingeführt wurden, das Potenzial, an anderer Stelle im Land repliziert zu werden. Die Stadt zeigt, dass ihre Umweltpolitik auf einem effektiven Multi-Level-Governance-System basiert, das einen Bottom-up- statt einen Top-down-Ansatz ermöglicht.

Russland/Moskau

Auf föderaler Ebene wird das Thema Umweltschutz in Städten derzeit durch eine Reihe von Gesetzgebungen und zwei übergreifenden nationalen Projekten (strategische Entwicklungsprogramme für bestimmte Gebiete und mit spezifischen Zielen bis 2030) definiert. Letztere schließen die nationalen Projekte "Umwelt" und "Wohnen und städtische Umwelt" ein. Dennoch sind auf der föderalen und häufiger noch auf der regionalen Ebene viele Elemente der Umwelt- und Stadtentwicklungsstrategien, der politischen Umsetzung und der Planung oft schlecht miteinander vernetzt, und es mangelt an einem ganzheitlichen und sektorübergreifenden Ansatz, der alle Elemente der städtischen Infrastruktur in ein nachhaltiges und belastbares System einbettet.

Der Vergleich der politischen Prioritäten auf nationaler und lokaler Ebene in Moskau zeigt, dass hauptsächlich die nationalen Prioritäten auf der lokalen Ebene repliziert werden. Allerdings

setzt Moskau auch eigene Prioritäten insbesondere in den Bereichen städtischer Grünflächen, Lärmbelastung und den Auswirkungen des Klimawandels. Ein Grund dafür ist der Status Moskaus als größte und ressourcenreichste Stadt (und auch Region) der Russischen Föderation. Weitere Erfolgsfaktoren sind die Auswahl politischer Instrumente, wie z. B. klare Ziele, Engagement der Stakeholder, Überwachung der Einhaltung von Maßnahmen und Gesetzen, steuerliche Anreize sowie Transparenz und Verantwortung der Stadtverwaltungen.

Die Replikation der Moskauer Umweltpolitik in anderen russischen Städten wird erleichtert, wenn Bereiche des Umweltschutzes auf lokaler und nationaler Ebene ähnlich priorisiert werden. Dann fördert der Top-down-Approach Wissenstransfer und staatliche Finanzierung von Maßnahmen auf lokaler und regionaler Ebene. Für eine erfolgreiche Replikation in anderen Städten benötigt der urbane Umweltschutz jedoch eine ganzheitlichere und umfassendere Koordination und Kommunikation von umweltbezogenen sektorübergreifenden Aktivitäten auf allen beteiligten Regierungsebenen.

Indien/Kochi

Der Erfolg in Indien resultiert aus der Zusammenarbeit verschiedener Institutionen auf unterschiedlichen politischen Ebenen sowie einer Kombination aus Top-down- sowie Bottom-up-Ansätzen. Dringliche städtische Umweltherausforderungen in Indien, wie etwa Klimaschutz und -anpassung, Luftverschmutzung, Wasserverschmutzung und Abfallaufkommen, wurden auf nationaler, regionaler und städtischer Ebene durch regulatorische Rahmenbedingungen und unterstützende Maßnahmen angegangen. Die ökologischen Herausforderungen und die entsprechenden Maßnahmen variieren je nach Stadt in Indien.

Der Fall Kochi zeigt, dass die Stadt sehr aktiv in verschiedenen Stadtentwicklungsprogrammen und Aktivitäten zum Schutz der städtischen Umwelt ist, hauptsächlich um die Luftverschmutzung und das Abfallaufkommen zu bekämpfen. Die Stadtverwaltung von Kochi spielt eine Schlüsselrolle bei der Durchführung der Klimamaßnahmen. Weitere erfolgversprechende Faktoren sind staatliche Finanzhilfen, Resilienz der Bevölkerung, Überwachung zur Einhaltung von Maßnahmen sowie internationale und städteübergreifende Zusammenarbeit.

Die Fallstudie von Kochi zeigt, dass ein erfolgreicher Ansatz bei der Bekämpfung von Umweltherausforderungen von der effektiven Kommunikation, Koordination und Entwicklung von Strategien von miteinander verbundenen und mehrstufigen Regierungsinstitutionen abhängt. Eine Replikation in anderen Städten wird daher erleichtert, wenn Top-Down- sowie Bottom-Up Ansätze ähnlich wie in Kochi den politischen Eckpfeiler für Maßnahmen im urbanen Umweltschutz bilden.

China/Peking

Die Regierungsstruktur der Umweltpolitik in China ist sehr komplex und basiert auf einer dualen Struktur. Einerseits werden politische Maßnahmen gemäß einer strengen Hierarchie (Top-down-Ansatz) umgesetzt. Andererseits verfügen Kommunalverwaltungen über ein hohes Maß an Entscheidungsfreiheit bei der lokalen Entwicklung und setzen die nationale Umweltpolitik mitunter auch selektiv unter Berücksichtigung ihrer lokalen Bedürfnisse um.

Die Fallstudie von Peking zeigt, dass die duale Struktur der chinesischen Umweltpolitik durch eine strikte Umsetzung von Maßnahmen der obersten nationalen Regierungsebene bis hinunter zur lokalen Ebene sehr erfolgreich sein kann. Insgesamt liegt der Erfolg in der Governance-Struktur, d.h. in der Kombination von vertikaler und horizontaler Integration (sektoren- und regionenübergreifend). Darüber hinaus spielen ein effektives Politikpaket sowie die wirtschaftlichen und personellen Ressourcen der Hauptstadtregion eine bedeutende Rolle. Ein

weiterer Schlüsselfaktor für Pekings erfolgreiche Umsetzung der Umweltpolitik, insbesondere in Bezug auf die Luft- und Wasserqualität, ist das umfassende Politikpaket, das verschiedene Schlüsselsektoren abdeckt. Dazu gehören spezifische Ziele und übergreifende Strategien (z.B. Fünf-Jahres-Aktionsplan für saubere Luft), spezifische lokale Gesetzgebung, Befehls- und Kontrollmaßnahmen, marktbasierte Instrumente, Umweltstandards, finanzielle Anreize und der öffentliche Zugang zu Informationen.

Peking verfügt über die wirtschaftlichen und personellen Ressourcen, um Umweltherausforderungen effizient zu identifizieren und zu bekämpfen; andere Städte haben jedoch möglicherweise keine vergleichbaren Bedingungen; die Replikation der urbanen Umweltmaßnahmen von Peking ist daher komplizierter und erfordert möglicherweise die Bereitstellung zusätzlicher Mittel.

Südafrika/Kapstadt

Südafrikas Erfolg bei der Bewältigung von Umweltherausforderungen lässt sich auf den kooperativen Governance-Ansatz zurückführen. Umweltbehörden auf nationaler, Provinz- und lokaler Ebene sind dafür zuständig, Umweltprobleme zu identifizieren, zu definieren und durch die Umsetzung der entsprechenden Richtlinien zu lösen. Erhebliche Entscheidungskompetenzen werden auf die Provinz- und auf die lokale Ebene übertragen. Ein Teil des Erfolges in Kapstadt ist daher auf das Subsidiaritätsprinzip zurückzuführen.

Die Politik in Kapstadt basiert auf Schlüsselprinzipien wie etwa der Beteiligung der Öffentlichkeit, der Sicherstellung der öffentlichen Akzeptanz der nationalen wie auch der lokalen Umweltpolitik in der Stadt, sowie auf Überwachungs- und Durchsetzungsstrategien, finanziellen Anreizen, dem Zugang der Öffentlichkeit zu Informationen, dem öffentlichen Bewusstsein sowie der Minimierung von Umweltproblemen an deren Ursprung. Ein weiterer Teil des Erfolgs in Südafrika ist der schiere Druck, aktiv zu werden. Südafrika und insbesondere die Region um Kapstadt gehören zu den biologisch vielfältigsten Gebieten der Welt. Zugleich ist Wasser in Südafrika eine knappe Ressource, was insbesondere für Kapstadt gilt. Südafrikas Hauptstadt ist daher ein Beispiel dafür, wie sowohl Top-down- als auch Bottom-up-Politiken in der nationalen, regionalen und lokalen umweltpolitischen Agenda des Landes effizient umgesetzt werden und diese zu einem gegenseitigen Lernprozess der verschiedenen Governance-Ebenen und der effektiven Zusammenarbeit zwischen ihnen beitragen.

Eine erfolgreiche Replikation des Umweltansatzes in Kapstadt wird daher durch eine effektive Zusammenarbeit zwischen den verschiedenen Regierungsinstitutionen erleichtert. Darauf aufbauend muss den Institutionen und Stakeholdern auf den verschiedenen Verwaltungsebenen die Möglichkeit gegeben werden, von einem gemeinsamen vertikalen sowie horizontalen Lernprozess zu profitieren, der die Anwendung sowohl von Top-down- als auch Bottom-up-Politiken an verschiedenen Standorten erleichtert. Darüber hinaus ist die Erfolgsgeschichte von Kapstadt das Ergebnis verfügbarer Investitionsströme und finanzieller Ressourcen, die die Umsetzung ambitionierter Ansätze erleichtern.

Indonesien/Jakarta

Indonesien hat die politische, administrative und fiskalische Dezentralisierung stark vorangetrieben und den regionalen und lokalen Regierungsinstitutionen mehr wirtschaftliche und politische Autonomie zugesprochen als es unter dem früheren Suharto-Regime der Fall war. Infolgedessen hat die Zahl der provinziellen und lokalen Regelungen und Richtlinien im Bereich Umweltpolitik zugenommen. Während der vergangenen Jahre zeichnet sich jedoch auch ein Trend zurück zu mehr zentralisierten Machtverhältnissen im Land ab. Infolgedessen wird die Umweltpolitik in mehreren Bereichen durch Top-down-Regulierungen bestimmt und ist von

einem komplexen Geflecht von Verwaltungsinstitutionen charakterisiert. Dies bringt unter anderem unklare Entscheidungsbefugnisse mit sich.

Jakarta hat nach und nach verschiedene sektorale und sektorübergreifende Politiken für den städtischen Umweltschutz entwickelt. Dazu gehören Instrumente zur Emissionsreduktion, Ressourceneffizienz, Verbesserung der Luftqualität, Abfallmanagement und nachhaltige Stadtplanung. Zu den Erfolgsfaktoren Jakartas gehören eine unterstützende lokale Stadtverwaltung mit der Vision Jakarta in eine Smart City zu entwickeln, kommunale Aktionsprogramme, Möglichkeiten für private Investitionen in öffentliche Dienstleistungen, Datenerhebungs- und Überwachungsaktivitäten sowie internationale Zusammenarbeit.

Im Kontext des jüngsten Trends in Indonesien zurück zur Zentralisierung politischer Befugnisse, erleichtert eine klare Definition der Entscheidungsbefugnisse die Replikation des erfolgreichen umweltpolitischen Ansatzes von Jakarta.

Empfehlungen

Die Fälle, die in dieser Studie vorgestellt werden, stammen aus Großstädten und Metropolregionen in ausgewählten sechs Ländern. Den Fallstudien zufolge sind die größten Herausforderungen Luftverschmutzung, Klimawandel und seine Auswirkungen, Landversiegelung/Landdegradation, Abfallmanagement und Wassermanagement. Diese Herausforderungen sind in Ländern und Städten weltweit bekannt. Die Handlungsfähigkeit der Länder und der jeweiligen Städte in dieser Studie resultiert zum einen aus massiven finanziellen und personellen Ressourcen, Investitionen in technische Fähigkeiten und der politischen Bereitschaft der jeweiligen Behörden. Es gibt aber auch andere Erfolgsfaktoren und vor allem andere Möglichkeiten, nachhaltige Stadtentwicklung und den Aufbau von Kapazitäten zu fördern. Im Folgenden werden wiederkehrende Muster von Erfolgsfaktoren aufgezählt, die nicht nur bei der Bewältigung traditioneller Herausforderungen zum Schutz der städtischen Umwelt, sondern auch bei neuen und aufkommenden Problemen angewendet werden können.

Muster 1 - Durchsetzung der lokalen Ziele durch nationale Regulierung: Umweltschutz auf städtischer Ebene beginnt mit bestimmten Zielen, die auf nationaler Ebene definiert werden, aber von den Entscheidungsträgern auf städtischer Ebene umgesetzt werden. Derartige Ziele schließen technische Standards oder Umweltstandards ein, die Spielraum für den Weg und die Mittel zur Erreichung der Ziele auf lokaler Ebene lassen.

Muster 2 - monetäre Anreize: Eine gängige nationale Strategie zur Förderung des Umweltschutzes auf lokaler Ebene ist die Bereitstellung von monetärer Unterstützung, die auf der Grundlage bestimmter Bedingungen zur Erreichung der festgelegten Ziele gewährt wird. Solche Ziele schließen die technische Ausrüstung, personelle Ressourcen oder vordefinierte Qualitätsstandards der Maßnahmen ein, die zum Schutz der Umwelt auf lokaler Ebene eingesetzt werden.

Muster 3 - Erleichterung lokaler Ambitionen durch nationale Richtlinien: Lokale Maßnahmen werden durch die Schaffung von Rahmenbedingungen auf nationaler Ebene initiiert. Dies beinhaltet etwa indikative Ziele oder Absichtserklärungen. Solche Richtlinien legen in der Regel die Zuständigkeit und Verantwortung für Aufgaben fest und fordern bestimmte Rechtsformen für Unternehmen und Partnerschaften.

Im Vergleich zu schnell wachsenden Megastädte in Schwellenländern, steht Deutschland vor anderen Herausforderungen. Die internationalen Fälle haben jedoch gezeigt, dass sich einige Grundprinzipien des städtischen Umweltschutzes als erfolgreich erweisen:

- Das Subsidiaritätsprinzip

- Ausreichende personelle und finanzielle Ressourcen
- Sektorübergreifende und langfristige Pläne und Strategien, ergänzt durch sektorale Politiken und Maßnahmen
- Umfassende Daten, Monitoring
- Mechanismen zur Einhaltung und Durchsetzung
- Eine Kombination aus Command-and-Control- und marktbasierter Politik
- Zusammenarbeit des öffentlichen Sektors mit der Zivilgesellschaft

Da die Forschung und praktische Erfahrung in Deutschland in einer Reihe von Handlungsfeldern weit fortgeschritten sind, können deutsche Institutionen auch zur Lösung neuer und entstehender urbaner Nachhaltigkeitsherausforderungen weltweit beitragen. So sind beispielsweise Lärmbelastung, Grünflächen- und Wasser-Infrastruktur oder Kreislaufwirtschaft in vielen Ländern relativ neu, während deutsche öffentliche Einrichtungen bereits auf Erfahrungen in diesen Bereichen zurückgreifen können.

Generell sollte sich die internationale Gemeinschaft weiterhin darum bemühen, die Wissensbasis zu stärken und Kapazitäten hinsichtlich der Frage auszubauen, wie die Umwelt auf städtischer Ebene geschützt werden kann. Darunter fällt unter anderem der Peer-to-peer Austausch sowie die Netzwerke zwischen Städten und Regionen. Die UN, multi- und bilaterale internationale Kooperationen und Städtenetzwerke können thematische Partnerschaften mit Städten bilden, die vor ähnlichen Herausforderungen stehen, um eine langfristige Stabilität der Politik zu gewährleisten. Darüber hinaus können Städte mit ähnlichen thematischen Herausforderungen auch Allianzen bilden, um auf nationaler Ebene auf robuste Maßnahmen zu drängen, die die Interessen der lokalen und regionalen Regierungen widerspiegeln, und globale nachhaltige Stadtentwicklungsstrategien auf subnationaler Ebene anwenden.

1 Problem definition

As the world faces an unprecedented era of increasing urbanisation, challenges to protect the environment at a city level increase in the same way. Cities can be both the source of environmental problems and solutions to the challenges that our world is facing today. The German Advisory Council on Global Change (WBGU) emphasises, that the momentum of urbanisation and its impacts are so massive, that the success or failure of a transformation towards sustainable development will be decided in cities (WBGU 2016). In that context it is crucial to develop and implement ambitious and innovative concepts and strategies to foster sustainable development at the urban level.

Usually, sustainable urban development is defined as an integrated, interdisciplinary and multi-dimensional approach, including environmental, social and economic issues (e.g. UBA 2018 for Germany). In Germany, the concept of *Tomorrow's cities* of the German Environment Agency outlines the vision of a sustainable city from an environmental perspective and highlights crucial measures to achieve, amongst others, environmentally friendly mobility, low noise, green spaces, compact housing and mixed-use districts (UBA 2017a). The German Environment Agency (UBA) continually develops further these concepts and strategies as part of its strategic research agenda "Urban Environmental Protection" (UBA 2018).

The aim of this study is to provide a detailed overview of the importance of environmental issues in urban development in selected countries, and to link the respective knowledge with the German approaches. On the one hand, the study searches innovative international approaches which may feed into German research and policy advisory activities. On the other hand, it identifies areas in which Germany could strengthen its activities to protect the environment at the urban level within an international context.

Background for such activities to cooperate on a global scale are international commitments such as the New Urban Agenda (NUA), the Sustainable Development Goals (SDGs) and the Leipzig Charter. All these documents aim at fostering national agendas fur urban environmental protection and they are also designed to facilitate transfer of knowledge and experience in this area.

The United Nations (UN) member states presented the NUA at the Habitat III conference in Quito during October 2016 (UN 2016). One of the main outcomes of the NUA was the adopting of a framework that aims to set the world on a course towards sustainable urban development focusing on how cities are planned, managed and inhabited. The NUA is supposed to be a toolbox for decision-makers at the local level and a political guideline reinforcing the commitment to sustainable and integrated urban development.

The UN's Sustainable Development Goals (SDGs) are a set of goals to end poverty, protect the planet and ensure prosperity for all as part of a new sustainable development agenda. SDG No. 11 explicitly highlights the importance of cities (UN 2015).

Similarly, the Leipzig Charter on Sustainable European Cities plays a significant role in the European context. In the Leipzig Charter, Ministers responsible for urban development commit themselves to making greater use of integrated urban development policy approaches and to pay special attention to deprived neighbourhoods within the context of the city as a whole. Comparable to the NUA, the Leipzig Charter points out policy targets such as creating and ensuring high-quality public spaces (EU 2007).An updated version of the Leipzig Charter will be adopted at the end of December 2020, including the new urban framework and the emerging challenges for urban agglomerations (EU 2020).The selected countries under analysis in this

study are Brazil, Russia, India, China, South Africa and Indonesia due to their progressing rapid urbanisation processes and their importance for German cooperation (e.g. KfW 2017, GIZ 2010).

The analysis of priorities of environmental protection in these countries and their approaches to resolve these issues enable a discussion about potential fields of activity and shall contribute to a process of mutual learning, how innovative approaches to tackle environmental challenges at the urban level could be transferred.

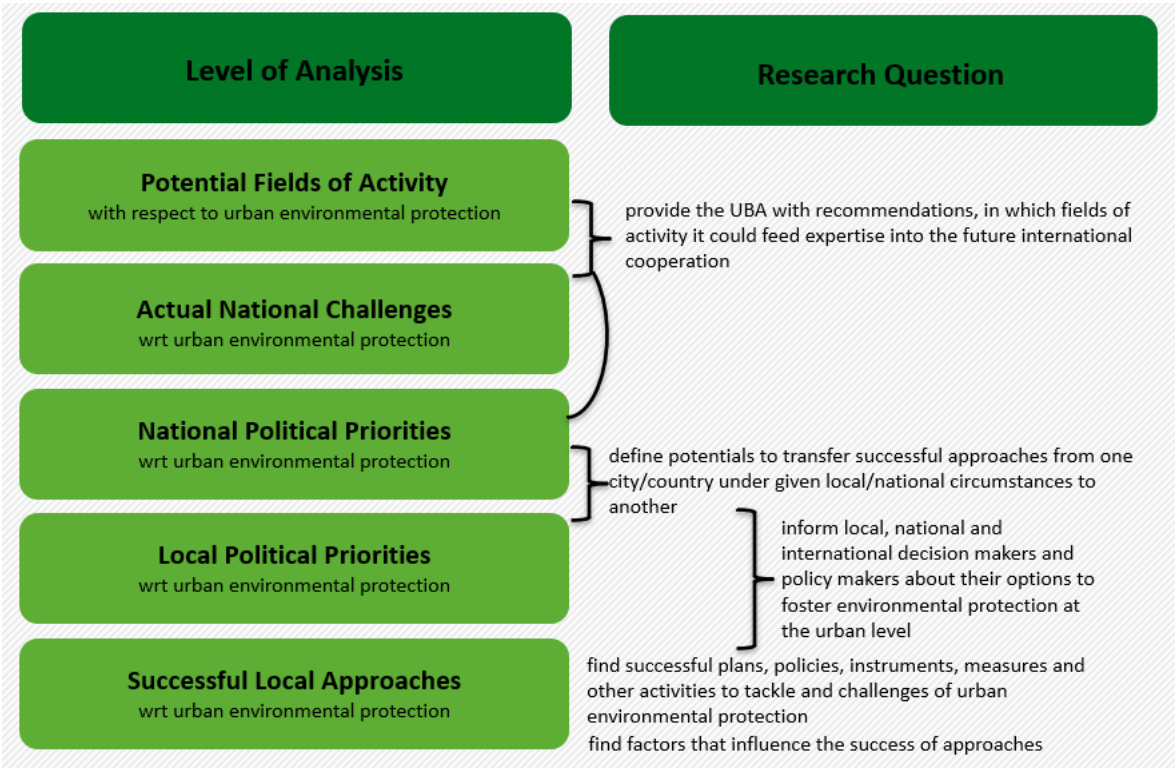
2 Methodology

The aim of this study is to identify significant environmental issues in urban development in selected countries and to provide the basis for a process of learning about innovative and successful approaches to tackle problems and challenges of urban environmental protection. More precisely, the aim is to

- find successful plans, policies, instruments, measures and other activities to tackle challenges of urban environmental protection;
- find factors that influence the success of these activities;
- define potentials to transfer successful approaches from one city/country under given local/national circumstances to another;
- inform local, national and international decision makers and policy makers about their options to foster environmental protection at the urban level; and
- provide the German Federal Environment Agency (Umweltbundesamt, UBA) with recommendations, in which fields of activity it could feed expertise into the future international cooperation.

To this end, a step-by-step procedure is applied as depicted in Figure 1. The left hand side of the Figure describes the analysis steps, the right hand side assigns the research questions to be answered (as listed above) to these steps.

Figure 1: Levels of analysis and corresponding research questions of this study



Source: Own illustration, Wuppertal Institute

First, we define potential fields of activity in urban environmental protection (see Table 1).

Second, we gather information about environmental challenges at the urban level in six pre-selected countries, namely Brazil, Russia, India, China, South Africa and Indonesia. We assess the extent of the challenge by reviewing sources with different perspectives. That is, we take into account scientific literature, expert opinions ("grey literature"), national public bodies, national civil society, and international and national media. This literature has mainly been found through online resources such as Google Scholar, Google News, Web of Science and websites of national institutions by using key words as listed in Table 1. The desk research was complemented with sources which were recommended by representatives of governmental und non-governmental bodies in the respective countries (however, mainly accessible online).

As a result, we provide an assessment of the actual extent of different kinds of environmental challenges using five categories. A challenge may be of (1) very high significance, (2) high significance, (3) medium significance, (4) low significance and (5) very low significance. The basis of the final categorisation is a verbal-argumentative assessment taking into account the following guiding questions:

- Which arguments and justifications are used to describe the extent and severity of a certain challenge?
- Are there any indicators to measure the extent of the challenge? If yes, do they exceed existing thresholds or do they indicate a certain extent of exposure as compared to similar regions or cities?
- What is the spatial extent of a certain challenge? How many cities in the respective countries are affected?
- What is the scope of stakeholders who have discussed a certain challenge? Do different groups take part in a discussion (science, experts, policy makers, civil society, media)?

Third, we assess the political priorities in the respective countries to resolve a certain challenge. That is, we evaluate the national action. At this stage, we do not aim to assess the actual success of the national action in dealing with environmental problems. This will be done in a later step by also taking into account local action and local outcomes.

In order to assess the political priorities, we analyse the policy formulation of key national policies and strategies to address the specific environmental challenge. We consider a priority high, if binding targets are set for the specific environmental challenge in key national strategies; we consider it of medium relevance if the specific environmental challenge has been explicitly mentioned in key national strategies, but without binding target; and low if the specific environmental challenge has not been referred to in any national strategies.

The above-mentioned key national policies and strategies could include or promote a policy package or they could be allocated a certain amount of money. If the desk research finds any assessment of the sufficiency of the policy package or the public funding, then this is taken into account as a further criterion to classify a priority as high, medium or low. The above-mentioned key national policies and strategies could also have been well implemented or have the potential for good implementation. Again, the analysis will take this into account.

We will then categorize the analyses from steps 2 and 3. The problems and challenges of urban environmental protection will be grouped into fields of activity for cities. Each environmental challenge may be assigned to several fields of activity, depending on the scope of the challenge. Table 1 provides an overview of fields of activity, which will be the basis for the thematic assignment. The categories have been selected based on the strategic research agenda on urban environmental protection and other publications of the German Federal Environment Agency

and Federal Ministry for the Environment (UBA 2018, UBA 2017a, UBA 2017b, BMUB 2017). For an international perspective, matches with the SDGs (UN 2015), the NUA (UN 2016) and the Leipzig Charter (EU 2007) have been verified.

Table 1: Fields of activity in urban environmental protection

Field of activity	Source
Participative planning	EU 2007, UN 2015, UN 2016, UBA 2017a, BMUB 2017, UBA 2018
Social inclusion	EU 2007, UN 2015, UN 2016, BMUB 2017
Housing and housing policy	EU 2007, UN 2015, BMUB 2017, UBA 2018
Climate change mitigation	EU 2007, UN 2015, BMUB 2017, UN 2016, UBA 2017b, UBA 2018
Resilience	UN 2015, UN 2016, UBA 2017a, UBA 2018
Smart City	EU 2007, UN 2015, UN 2016, UBA 2017a, UBA 2018
Land sealing and soil degradation	EU 2007, UN 2015, UN 2016, UBA 2017a, UBA 2017b, BMUB 2017, UBA 2018
Air pollution	UN 2015, UN 2016, UBA 2017a, UBA 2018
Noise reduction	UN 2015, UN 2016, UBA 2017a, UBA 2018
Sustainable mobility	EU 2007, UN 2015, UN 2016, UBA 2017a, UBA 2018
Adaptation to climate change	UN 2015, UN 2016, BMUB 2017, UBA 2018
Resource protection, urban mining	UN 2015, UN 2016, UBA 2017b, UBA 2018
Waste management	EU 2007, UN 2015, UN 2016, UBA 2017b, UBA 2018
Public health	UN 2015, UN 2016, UBA 2017a, BMUB 2017, UBA 2018
Water pollution	EU 2007, UN 2015, UN 2016
Green public space	EU 2007, UBA 2017a, BMUB 2017, UBA 2018
Environmental justice	UN 2015, UN 2016
Conservation of Biodiversity	UN 2015, UN 2016, UBA 2017a, UBA 2018

Source: Project results based on expert discussions and own research, Wuppertal Institute

Fourth, we analyse six cities in the mentioned countries (one city per country). These cities are exemplary for two reasons. First, they have been selected because their challenges to protect the environment and their priorities largely coincide with those of the country. Second, they have already implemented policies, measures and other initiatives which are successful. This had been confirmed by national stakeholders in an early stage of the research.

The six cities are

- Belo Horizonte in Brazil
- Moscow in Russia
- Kochi in India
- Beijing in China
- Cape Town in South Africa
- Jakarta in Indonesia

Similarly to steps two and three, we analyse the policy documents to describe challenges and political priorities. These documents are urban land-use plans (cross-sectoral), sectoral master plans as well as concrete urban policies/by-laws. We conduct this analysis in order to a) classify them in an overall picture of activity fields and b) understand the effectiveness of the plans and instruments.

The best quality for assessing the effectiveness of instruments and measures are statistical time series that provide information on specific issues. Thematically focused information is often provided through local statistics and surveys. In some cases, cities have carried out their own analyses of the effectiveness of specific instruments and measures. In addition, we searched for analyses from experts and the scientific community. Thus, the evaluation methodology is largely determined by data availability.

That being said, in many cases the effects of small-scale activities at the local level may be too little to justify an evaluation. Moreover, the data quality on the local level varies and appears to be poor in many cases. Cities are also mainly interested to understand the effects of their overriding interventions and aim to discuss good practice. In consequence, high quality data and in-depth analysis is only available for meaningful and successful activities and interventions, in other words: the successful few. However, the research interest of this study is to find good practice examples with a view to analyse transferability. From this perspective it is worthwile to highlight good practice cases.

Therefore, each city case (Belo Horizonte, Moscow, Kochi, Beijing, Cape Town and Jakarta) includes two spotlights describing ambitious interventions (policy packages) in a certain sector to combat a certain challenge. The data availability of these (at least partly) successful activities is robust enough to disclose the mechanisms of the interventions and the reasons for their success.

Conclusions

The study concludes by providing

1. a summary of successful plans, policies, measures and other interventions to tackle challenges to protect the urban environment. The summary is based on the 12 spotlights.
2. an analysis why those cases were successful. The analysis takes into account the efforts from the national counterparts and the interaction of policy levels.

3. a discussion of transferability. This discussion is based on a comparison of fields of activities between the countries. Moreover, it includes success factors which are relevant irrespective of the political system (governance of policy levels, see 2.)
4. recommendations about the possibilities to foster environmental protection at the urban level in the international context. The recommendations will be directed to the German Federal Environment Agency (UBA), to other national institutions such as the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), to cities worldwide, and to inter- and transnational bodies such as the UN, EU and city networks.

3 Country overview

This section provides an overview on some demographic and socio-economic aspects in the six countries which are analysed with regard to their challenges to protect the urban environment. The comparison points to heterogeneous initial situations. The urban transition processes of Brazil, Russia, India, China, South Africa and Indonesia vary substantially (Department of Economic and Social Affairs, United Nations 2015; p.45). Population sizes as well as urbanisation shares and urban settlement levels are summarized in Table 2.

Table 2: Urban population share of selected countries

Country	Total Population	Urban Population Share
China	1.40 billion	60.3%
India	1.37 billion	34.5%
Indonesia	271 million	56%
Brazil	211 million	86.8%
Russia	144 million	74.6%
South Africa	59 million	66.9%

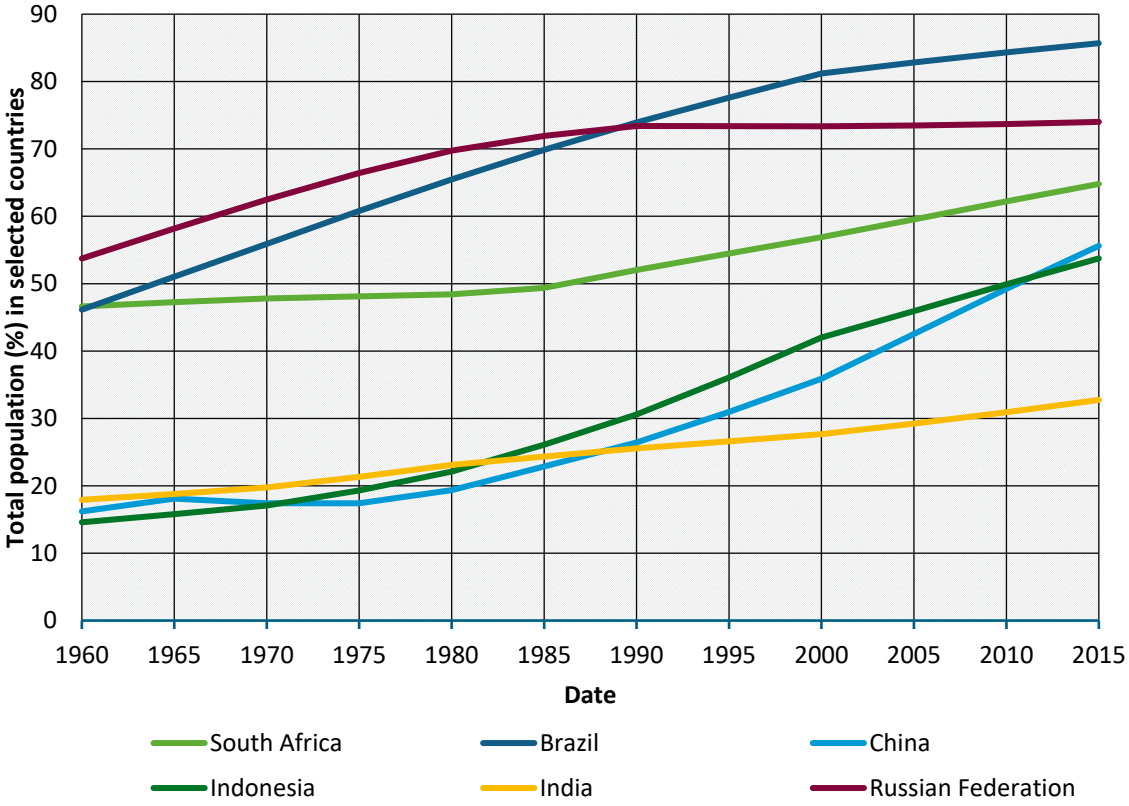
Source: World Bank 2019

With a population size of approximately 1.4 billion and an urban population share of 60.3%, China has encountered an unprecedented urbanisation process during the last three decades. Similarly, the level of urbanisation in India, with a total population of over 1.37 billion people, is almost twice as large as compared to 1950, reaching a share of 34.53% in 2019. Moreover, the Indian rural population is expected to drop by 52 million individuals between 2014 and 2050 (Department of Economic and Social Affairs, United Nations 2015; p.15). Similar phenomena can be observed in other countries analysed. Brazil, for instance, has a population size of almost 211 million people and an estimated urbanisation share of 86.8%, whereas South Africa has a total number of 59 million citizens out of which 66.9% live in urban areas; Indonesia in turn has a total population of around 271 million people with 56% living in urban settlements (World Bank 2016). Finally, of around 144 million people in Russia, 74.6% reside in urban areas (Table 2 & Figure 2).

While the urban population is predicted to rise in the following decades in five of the six selected countries, only Russia´s urban settlements are growing very slowly. (Department of Economic and Social Affairs, United Nations 2015 p.14). According to UN World Urbanisation Prospects (2018), the urban population in Russia will rise by around 3 million by 2050, reaching 110.6 million people in total, which is equivalent to a 74.4% urban population share.

Moreover, the six countries differ considerably with regards to their social development. One indicator is the Human Development Index (HDI), including the dimensions health, education and standard of living. Russia with a HDI score of 0.804 is categorised as a country with very high human development (Department of Economic and Social Affairs, United Nations 2015), positioning it at 49 out of 188 countries (United Nations Development Programme 2016; p.2). While Brazil with a HDI score of 0.754 and China with a HDI score of 0.738 are classified as countries with a high human development, Indonesia (0.684), South Africa (0.666) and India (0.624) are considered as countries with medium human development (United Nations Development Programme, Human Development Index, Table 3).

Figure 2: Total urban population (%) in selected countries



Source: Own compilation, based on World Bank 2016, Wuppertal Institute.

Table 3: Human Development Index

Human Development Level	Category
Very high human development	0.800 and above
High human development	0.700 – 0.799
Medium human development	0.550 – 0.699
Low human development	0.550

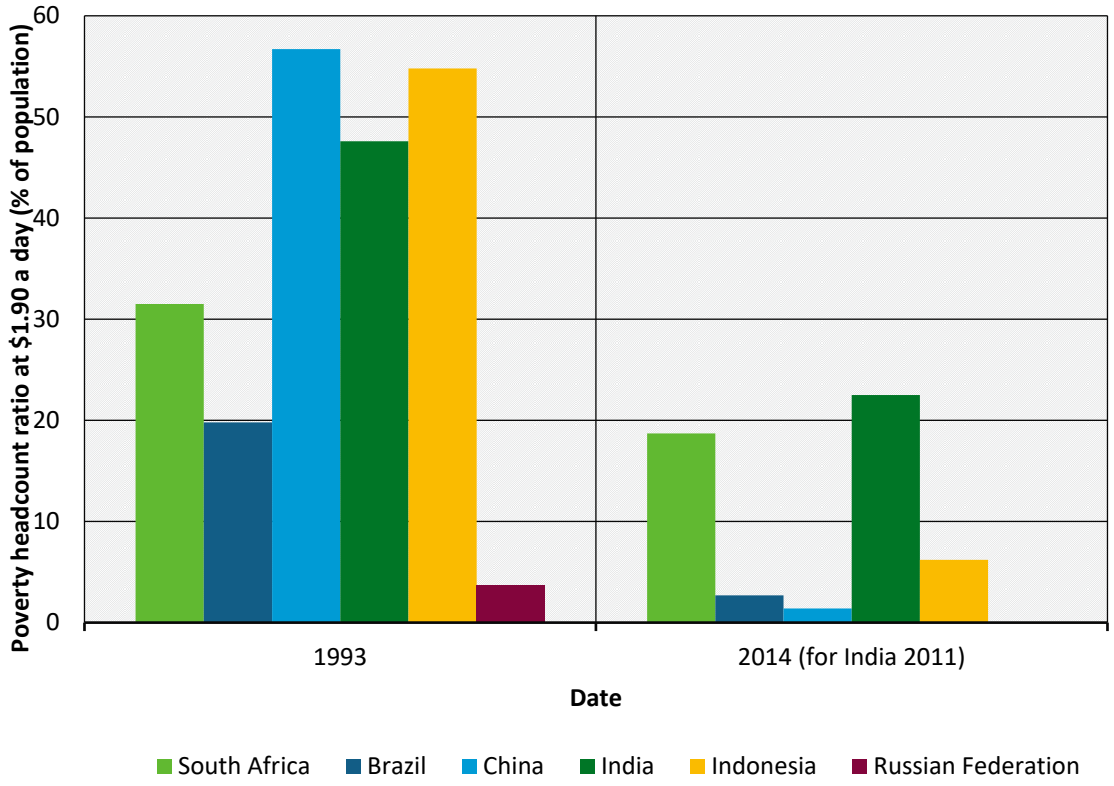
Source: United Nations Development Programme, Human Development Index, Technical Notes.

A second indicator for the social development status of the analysed countries is the Gender Inequality Index (GII). It assumes a negative correlation between gender inequality and human development. Hence, the higher the disparities between females and males, the higher the loss to human development. China ranks 37 among all countries considered in the Index, having a score of 0.137. Russia, with a score of 0.271 is positioned at 52 out of 188 countries; South Africa has a score of 0.394, positioned at rank 90; Brazil has a score of 0.414, positioned at rank 92; at rank 105 is Indonesia with a score of 0.467 and finally, at rank 105 with a score of 0.530, is India (United Nations Development Programme, Gender Inequality Index).

Finally, the percentage of population that is living below the poverty line (poverty is considered in absolute terms), which is set at a value of 1.90$ a day, serves as a third indicator. As Figure 3 shows, all six countries managed to lower considerably the percentage of people living below the poverty line between 1993 and 2014. These years were chosen as reference points since

data is available for almost all six countries (although the most recent data for India stems from 2011). Russia ranks best with 0% of its population living below the poverty line in 2014, followed by China with 1.4%, Brazil with 2.8%, Indonesia with 7.9% and South Africa with 18.9%. India ranks worst with more than one fifth of its population receiving less than 1.90$ a day (World Bank, Poverty Headcount Ratio). Other indicators, such as the income equality as measured by the Gini Index similarly point to substantial differences of the six countries' social development.

Figure 3: Poverty headcount ratio at $1.90 a day (% of population)



Source: Own compilation, based on World Bank 2016, Wuppertal Institute.

In the context of globalisation, large structural economic modifications have been realised, changing the sectorial shares of the respective economies to stay competitive on an international level. Considering this, China stands out with regards to the large-scale shifts in its economic framework. By 2030, China is expected to become the largest economy in the world due to its rapid economic progress. It has not only expanded its service sector (up to 53%), but also its industrial sector (up to 40%) as well as the agricultural sector (up to 8.2%). Similarly, India´s service sector represents its largest source of economic growth, accounting for approximately two-thirds of GDP and 46.6% with regards to its sectorial share (Central Intelligence Agency, 2016).

This section has shown the heterogeneity with regards to socio-economic aspects of the countries (and cities in these countries) that are analysed in this report. Amongst others, this heterogeneity determines urban environmental challenges and political priorities to tackle these challenges. Oftentimes, cities aim to tackle all ecologic, social and economic challenges in their comprehensive urban development strategies.

4 Urban environmental challenges in Brazil

This section describes challenges of urban environmental protection in Brazil with subchapters for different challenges. Per subchapter, the challenge and its impacts are described. Then, the extent of the challenge is assessed by analysing affected cities and national stakeholders' perceptions. The final section summarises the findings of the challenges' significance. The chapters regarding urban environmental challenges in the other five countries will be similarly structured.

4.1 Air pollution

Brief description

Air pollution in urban areas is related to a number of factors, such as vehicle traffic, the burning of fossil fuels in the energy sector and industrial activity. According to the World Health Organisation (WHO), 9 out of 10 inhabitants of the 4,300 cities monitored worldwide by the Urban Ambient Pollution Database breathe polluted air. This causes the death of 7 million people each year, the majority of which occurs in low-income countries in Asia and Africa (Miles, 2018).

Despite the fact, that Brazilian cities are not among the most polluted ones when compared to Indian or Chinese urban areas (AirVisual, 2019), the industrialisation process, the increasing urbanisation, the growing motorisation rate, as well as deforestation and fires, have turn it into a major environmental issue with important social and economic impacts.

The main emitter of local pollutants in urban areas in Brazil stems from vehicles. The use of fossil fuels in motorised transportation is responsible for the emission of several pollutants that affect human health and degrade the urban environment, in particular carbon monoxide (CO), hydrocarbons (HC), particulate matter (PM), nitrogen oxides (NOx) and sulphur oxides (SOx) (Ribeiro de Carvalho, 2011). Aldehydes (RCHO) are also relevant in the Brazilian context as it is associated to the use of ethanol in cars.

Between 2008 and 2018, the total number of automobiles in Brazil increased from 37.1 million to 65.7 million, being the seventeen main metropolitan regions responsible for 40% of this growth. The motorization rate (defined by the total number of cars divided by one hundred inhabitants) went from 19.6 to 31.5 in Brazil and from 26.1 to 38.3 in the metropolitan regions in the same period (Matos de Oliveira, 2019).

As for rural areas, in the analysed period, the greatest absolute growth in the number of automobiles occurred in the Southeast, going from 21 million to 35.2 million. The motorization rate in the Southeast goes from 26.2 autos/100 inhabitants. to 40.1 autos/100 inhabitants. However, the highest percentage growth occurred in the Northern region, which went from just over one million automobiles to over 2.3 million, representing a growth of 116% (Matos de Oliveira, 2019). Another reason for air pollution is related to induced fires for agricultural purposes.

Nevertheless, it is worth noting that Brazil has made great progress in terms of air pollution thanks to its biofuels and vehicle technical inspection programmes introduced in the 1970s. In fact, Brazil is one of the largest producers and consumers of biofuels. Most of its vehicles run on a mixture of ethanol and gasoline. Moreover, Brazil is pioneer in the implementation of Bus Trapid Transit System (BRT), an innovative transportation system that has revolutionised mass transit in developing and emerging economies.

Impacts

The WHO states that 25% of the deaths for stroke, heart disease or lung cancer worldwide are due to the poor air quality in cities (Miles, 2018). According to a study of the Brazilian Ministry of Health, the deaths related to air pollution increased 14% between 2006 and 2016, going from 38,782 to 44,228 (Ministério da Saúde, 2019). In 2018, the cost of hospitalizations related to respiratory problems exceeded R$ 1.3 billion nationwide. Sao Paulo`s expenses for health care associated with air pollution for instance account for $300 million per year (Semenário, 2018).

Despite the high mortality rate for Noncommunicable Diseases (NCD) in Brazil in 2016 (721 per 100,000 for men and 551.0 per 100,000 for women), the trend for all-cause mortality rates of NCDs is decreasing. NDCs are defined as non-transmissible diseases which are chronic by nature, caused by genetic, physiological, environmental and behavioural factors (WHO 2020). The same declining trend was observed for NCDs attributed to air pollution. The study conducted by the Ministry of Health states that the improvements in air quality, especially in relation to the pollutant PM2.5, might be due to technological innovations in the sectors linked to the production and improvement of fuels, automotive, other industrial sectors, and also more sustainable urban policies, having contributed to the decline observed between 2006 and 2016.

Affected Cities

Due to a lack of an appropriate infrastructure that accompanies the rapid urbanisation rates in Brazil, all large urban areas face high air pollution levels. Compared to the WHO Annual Guideline Levels of air pollution, the annual mean of air pollution in Brazilian cities lied on average above the corresponding WHO standards in 2015 (see also Table 4). In 2015, the cities with the highest levels of particulate matter (PM10) included Santa Gertrudes (81), Sao Joao De Meriti (65), and Cubatao (61). Brazil´s largest city Sao Paulo had a PM10 level of 28 in 2016, whereas its second largest city Rio de Janeiro had an annual pollution level of 42 in 2015. With regard to PM2.5, the three cities with highest air pollution levels included Santa Gertrudes (37), Cubatao (28) and Rio Claro (22) in 2015. (WHO Ambient Air Pollution City Database, 2018). The Metropolitan Region of São Paulo is the sixth most polluted in the country, with 19 micrograms of PM 2.5 per cubic meter. Rio de Janeiro, with 16 micrograms, and Curitiba, with 11, are the other two Brazilian capitals that exceeded the WHO recommended limits in 2016 (IHU, 2016).

Table 4: Comparison between Brazilian ambient air pollution levels in cities and WHO standards

Pollutant	WHO Annual Guideline Levels	Average Pollution Level (2015)
PM2.5	10	13,63
PM10	20	31,77

Source: Own compilation, based on WHO Annual Guideline Levels and WHO Ambient Air Pollution City Database, Wuppertal Institute

In Brazil, most of the studies on the impact of air pollution on health were conducted in the state of São Paulo or in other large urban centres. Moreover, not all federal units have air quality monitoring stations. While the Southeast (76%) and South (13%) regions concentrate most of the country's stations, the North, Midwest and Northeast regions have an enormous lack of air quality monitoring devices in their jurisdictions. In addition, not all stations monitor the same pollutants, with PM10 and/or PM2.5 monitored in 82% of the stations and O3 in 46% (Ministério da Saúde, 2019).

Stakeholder Perception

National and international agents perceive air pollution in Brazil as a risk to human health as well as to the ecosystem and highlight the importance to introduce mitigation actions. An

extensive academic literature on air pollution highlights the challenges as well as impacts of air pollution in the country (e.g. Costa et al. 2017, Tischer et al. 2019). The World Resources Institute (WRI) in Brazil states that even though it contributes to causing thousands of deaths every year, this is an issue that Brazilian governments have neglected for a long time. According to WRI, there is a consensus among experts on the subject: the Brazilian legislation on the subject is outdated and its updating would be the first step towards public policies to control and improve air quality (WRI Brazil, 2018).

4.2 Climate change and its effects

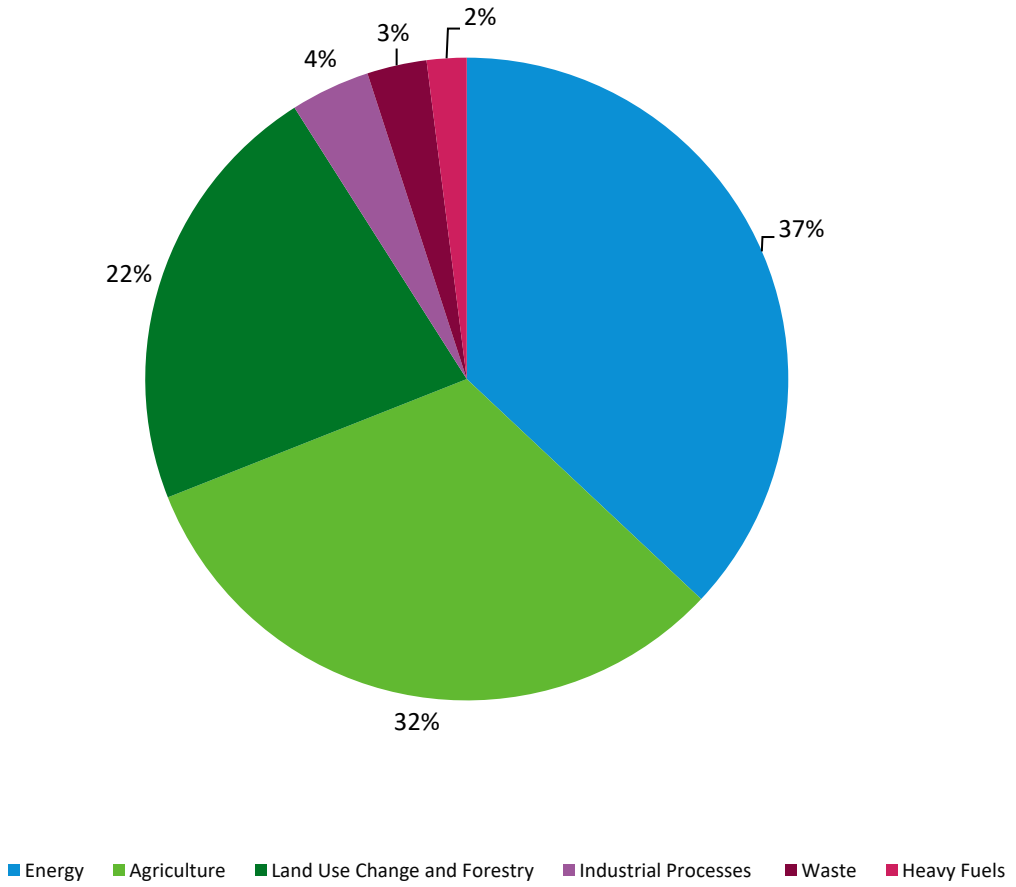
Brief description

Brazil is the 7th largest emitter of greenhouse gases in the world (WRI 2017). In 2014, Brazil's GHG portfolio comprised six main emitting areas: The largest fraction of GHG emissions stemmed with 37% from the energy sector, including electricity/heat, manufacturing/construction, transportation as well as other sectors. This is followed by agricultural emissions with 32%, land-use change and forestry with 22% and by smaller fractions stemming from industrial processes, waste and bunker fuels. Moreover, according to the 2026 Decenal Plan of Energy Expansion, emissions of the energy sector are expected to increase to 57% of total emissions in 2026 (Ministério de Minas e Energia, 2017).

Nevertheless, Brazil has achieved remarkable progress in reducing its GHG emissions since 2005. With 40 per cent of renewable share in the energy sector, Brazil has almost reached its Nationally Determined Contributions (NDCs) target of 45 per cent by 2030 (Arioli et al. 2018). Other sectors, such as energy, transport and industry will even be able to increase their emissions compared to 1990 levels without risking the achievement of the target. GHG emissions from Brazilian cities account for 29 per cent of total national emissions (The Worldbank Group, 2010).

However, the positive trend in Brazil´s policy of emission reduction seems to have ceased in 2016 (CAT 2018). On the one hand, urban emissions are increasing most rapidly due to the population and economic growth (The WorldBank Group, 2010). On the other hand, an increase in deforestation by 30 per cent with more than a half in the Amazon area, emitting approximately 130 MtCo2 alone in 2016, conflicts Brazil´s commitment to the Paris Agreement, including amongst others the aim of complete abolition of illegal deforestation (CAT 2018). Moreover, despite of the rise in ethanol use for vehicles, the road passenger transportation was still based with 70 per cent on fossil fuels in 2010. As a consequence, CO2 emissions generated by the burning of fuels in passengers´ road transportation sector experienced a permanent rise since 1985 (Federal Government of Brazil/IPEA/MP, 2016). Another pollutant factor is waste production and disposal. Since 1970, the amount of urban waste has increased annually by 4 per cent and is expected to increase the overall GHG emissions (The WorldBank Group, 2010).

Figure 4: Brazil's GHG emission portfolio



Source: Own compilation, based on CAIT 2014, Wuppertal Institute.

Impacts

According to CAT (2018), due to the controversial stance of Brazil´s government with regards to environmental policies, GHG emissions are expected to rise until 2030. CAT (2018) rates Brazil´s commitment to the NDCs, therefore, as "insufficient" as it is inconsistent with the 2°C threshold. Furthermore, as expressed in the Habitat III report, on a national level, Brazil experiences negative impacts from climate change (e.g. degradation of coastal areas due to the rise of sea level) and the consequences it entails such as the occurrence of extreme whether events (e.g. flooding) associated with short- or long-term displacements, human health challenges, diseases as well psychological consequences generated through casualties or material losses. To illustrate this point, throughout the period 2006 to 2014, 11,399 natural catastrophies of different intensities occurred (Federal Government of Brazil/IPEA/MP, 2016).

Furthermore, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) affirms that some of the effects to be experienced in Brazil will be (WWF Brazil, 2014):

- In northeastern Brazil, semi-arid and arid areas will suffer a reduction in water resources due to climate change..
- Estimated groundwater recharge will decrease dramatically by more than 70% in northeastern Brazil (compared to 1961-1990 and the 2050s).
- The sea level, climate variability and disasters caused by climate change are expected to have impacts on mangroves..

- From 38 to 45% of cerrado plants are at risk of extinction if temperatures increase by 1.7°C from pre-industrial levels.

Affected Cities

According to a study about the impact of climate change on the national infrastructure in Brazil, urban infrastructures in various cities, e.g. Recife, Fortaleza, Sau Paulo or Rio de Janeiro, are not appropriate to cope with climate changes. Excessive soil sealing in combination with extreme weather events highlight the need for the adoption of resilient and sustainable urban infrastructure, e.g. the construction of larger river beds and permeable zones (Federal Government of Brazil/IPEA/MP, 2016). Rainfall will increase in the southeast with a direct impact on agriculture and an increase in the frequency and intensity of flooding in large cities such as Rio de Janeiro and São Paulo (WWF Brazil, 2014).

Moreover, cities that are located in the proximity of the coast, are threatened by a rise in the sea level. "The environmental degradation of coastal areas could translate into loss of touristic, residential and other assets, and increased insecurity for local residents" (The WorldBank Group, 2010). Since approximately 60 per cent of the population lives in coastal areas, cities are heavily affected by the consequences of climate change (Allison, 2017).

Generally, the urban poor in large metropolitan areas are particularly threatened by the aforementioned aspects. Nationwide, around 11,4 million individuals live in favelas (Bello, 2018). In Rio de Janeiro, around 20 percent of total inhabitants have their home in around 643 favelas, located in risk-prone areas, e.g. threatened by flooding and landslides (The WorldBank Group, 2010).

Stakeholder Perception

Due to its size, the volume of its emissions and its natural resources, Brazil plays a key role in the fight against Climate Change. Moreover, it has the potential and important characteristics to be a global reference in the balanced development with the environment, in the massive production of renewable energy, biodiversity products, agriculture with reduced impact on the environment (which includes not only actions that reduce GHG emissions, but also optimization in the use of fertilizers, agrochemicals, etc.). Several of these alternatives have been and can be financed by the international community, and become an opportunity for Brazil in the international market (for example for agricultural products). Brazil already advanced towards a sustainable development model and a sound climate change policy, which was very well regarded worldwide (Krug, Ometto, Aragão, & Vinhas, 2019). However, the declarations and policies implemented by the current president of Brazil, Jair Bolsonaro, during his first year in office have call the attention of the international community towards an environmental and economic policy that might threaten the previous achievements of Brazil, mainly in terms of deforestation and loss of biodiversity.

4.3 Water pollution and availability

Brief description

Although Brazil possesses one of the world´s largest water resources, water has become a scarce good and is defined by an asymmetric distribution among the Brazilian population. Especially urban areas experience water shortages; the 45 per cent of the urban population, that are situated along the coast, receive only 3 per cent of available drinking water, the rest being used for agricultural or industrial activities or being tansported to other urban settlements in the country.

Moreover, water becomes increasingly contaminated in Brazil. Factors such as the rapid increase in population and the resulting rise in waste production contribute to this process. Furthermore, approximately one third of potable water gets lost due to an inadequate distribution system, containing many leakages. Moreover, rivers are polluted through industrial waste. In that context, although rivers represent a public good.Ddownstream cities face a higher pollution level than upstream cities, leading to disputes and conflicts over water management (Osava, 2006). Finally, agricultural activites, in particular the cultivation of monocultures (e.g. soybean and sugarcane monocultures), affects water quality. For instance, the discharge of the acidic residue (vinasse) in rivers is one of the largest sources of water pollution in ethanol production zones in Brazil.

Impacts

Since contaminated water contains "high levels of bacteria and viruses that would likely lead to stomach and respiratory illness" (Lacey 2018), more investments into water treatment but also into health insurances for the Brazilian population are needed. Besides that, water and soil pollution have negative effects on the environment and, linked to that, to some economic branches of the country. For instance, due to water contamination the fishing industry experiences large economic losses since fish and wildlife populations in particular at Brazil´s coast decrease. Although the Brazilian government established so-calles "ecobarriers" across channels and rivers to prevent garbage being floated downstream into the Atlantic, these eco-barriers do not have their desired effect. Instead, while only collecting 7.5 per cent of downfloating garbage, they also inflict losses to many local fishing communities situated at the countryside (Lacey 2018).

Affected Cities

Water scarcity affects in particular the cities that are located on the cost, but also settlements that are located in semi-arid regions in the north-east of the country.

Whereas soil pollution affects preliminary agricultural areas and the non-urban environment, water pollution is a sensitive issue in cities. For instance, water pollution affects more than 30 million people alone in Brazil´s largest cities – Sao Paulo and Rio de Janeiro. Both cities are in close proximity to the sea; however, their costal lines are heavily polluted due to raw and untreated seweage flows from rivers and channels into the Atlantic. Although in 2013, almost 97 per cent of urban households had access to the water network in Rio de Janeiro, the water contamination is particularly high in low-income parts of the city, where water infrastructure and sewage treatment are inadequate (Federal Government of Brazil/IPEA/MP, 2016; Lacey 2018).

Stakeholder Perception

National and international agents perceive water and soil contamination in Brazil as a risk to human health as well as to the ecosystem and highlight the importance to introduce mitigation actions. An extensive academic literature highlights the challenges as well as impacts of water and soil pollution in the country. International organizations as well as non-governmental organizations point to the negative effects water and soil pollution entails on its environment. National authorities introduced various binding and non-binding initiatives. A large part of the literature highlights the impacts of an inadequate waste collection system on the water quality as well as the quality degrading nature of agricultural activities.

4.4 Loss of Biodiversity

Brief description

Due to its rich biodiversity, Brazil is a member of the 17 “megadiverse countries” of the world (UNESCO, n.d.). It exhibits 70 per cent of species worldwide and 20 per cent of the world´s total biodiversity. As such it “is home to a least 103,870 animal species and between 43,000 and 49,000 plant species (…). Approximately 700 new animal species are discovered each year in Brazil, and a new plant species is identified approximately every two days” (Secom, 2012). Brazil’s terrestrial area is divided into six biomes, namely the Amazon Biome, which is largest, followed by the Cerrado biome, the Atlantic Forest Biome, the Caatinga Biome, the Pampa Biome and finally the Pantanal Biome (Secom 2012).

However, the industrial and agricultural activities have led to a substantial loss in biodiversity. In the Cerrado biome, for instance, studies show that “the levels of habitat destruction are rampant and only 50 per cent of its natural cover remain” (Francoso et al., 2015). Other scientists stress that if no major political reforms are introduced, the Amazon will experience a 31-44 per cent loss of species by 2030 (Ochoa-Quintero, 2015). Global Forest Watch (2020) states that between 2001 and 2020, Brazil has lost around 56.4 mega hectare of tree cover, being equivalent to around 11 percent decrease in forests since 2000. In total this loss of tree cover equals a CO2 emission of around 19.3 gigatons.

Major causes for this loss in biological diversity include deforestation (e.g. through logging, fire, farming, cattle ranching as well as of monocultures, especially sugarcane production), degradation through climate change and air pollution. Especially the creation of pasture for livestock increases deforestation rates, since Brazil is one of the largest producers of meat. Agricultural land represents around 33.94 percent of Brazil’s total land area according to World Bank data (World Bank 2016).

Impacts

Monocultural activities do not only contaminate water and soil through large-scale usage of herbicides and pesticides, they also have a huge effect on the natural ecosystem of the country. Although monocultures such as sugarcane and oil seeds do have a positive effect on GHG emissions as biofuels for the transport sector in particular in cities, they entail huge environmental costs. A study UNEP-WCMC study shows that in 2009, some 20 percent of biologically diverse areas are identified as being located in the Cerrado biome; at the same time, 70 per cent of this area overlaps with potential sugarcane expansion areas. Moreover, the study claims that already approximately 66 per cent of the Cerrado biome are degraded; consequently hundreds of species are at risk (UNEP and WCMC 2009).

Affected Cities

Cities are only indirectly affected (e.g. loss of ecotourism, loss of environmental services).

Stakeholder Perception

National and international agents perceive the loss of biodiversity in Brazil as a risk to the ecosystem and highlight the importance to introduce mitigation actions. An extensive academic literature on biodiversity loss highlights the challenges as well as impacts in the country. International organizations as well as non-governmental organizations point to the negative effects the loss of biodiversity entails on its environment. National authorities introduced various binding and non-binding initiatives. The literature relates the loss of biodiversity mostly only indirectly to urban settlements.

4.5 Land degradation and deforestation

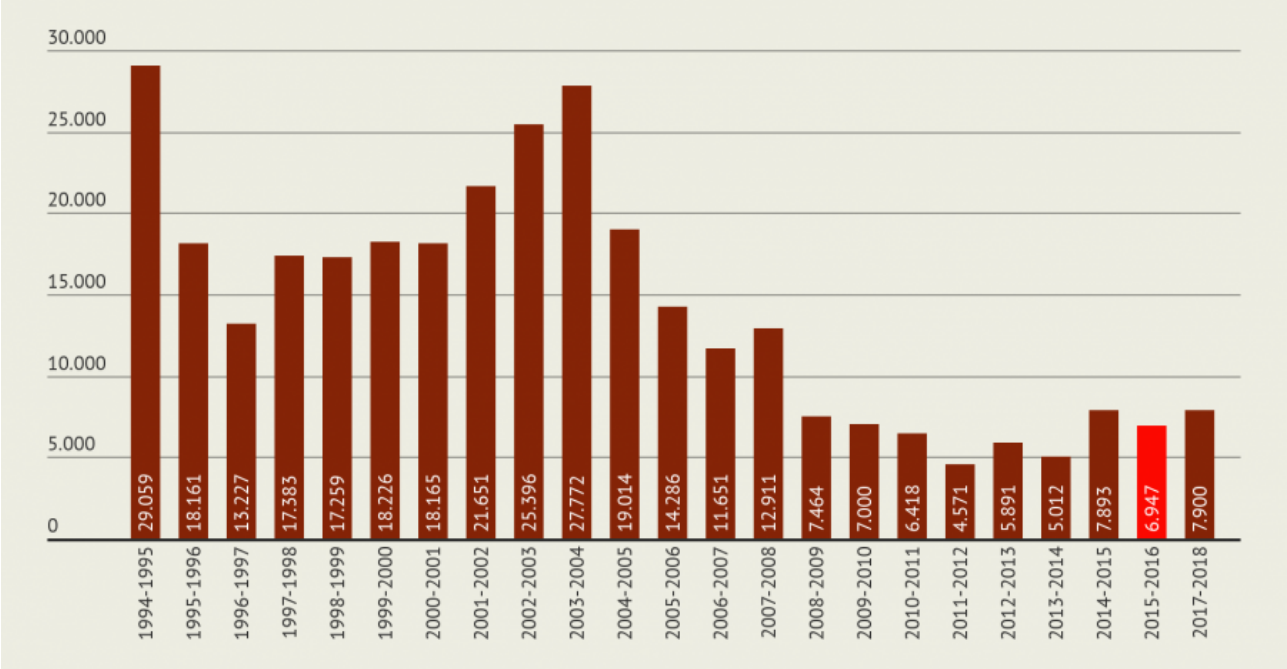
Brief description

Industrial activities such as mining, the development of infrastructure, population growth, monocultures of soybeans and sugarcane crops, cattle ranching, logging activities and land tenure have increased deforestation in Brazil. Practices such as extensive grazing, soybean and oil palm monocultures generated almost 70% of deforestation in Latin America between 2000 and 2010 (Ramos, 2019).

About 75% of Brazilian emissions of CO2 are related to deforestation. Deforestation rates peaked in 2004 with 27,772 km2/year. In the same year. gradual decrease started, with a significant drop im 2009 reaching the lowest rate in 2012 with 4,571 km2/year (See Figure 5), i.e. a decrease of 83% in the period 2004-2012, which resulted from the implementation of the Action Plan for the Prevention and Control of Deforestation in the Amazon (PPCDAM for its Portuguese acronym) (ISA, 2019)and other regulations such as the Agricultural Zoning Decree approved in 2009 . A new growing trend that took the deforestation rates to the 7,000 km2/year – levels started in 2015 (ISA, 2019). “Emissions from land-use change grew 23 per cent in 2016, accounting for roughly half of all greenhouse gases released into the atmosphere by Brazil. This was driven by a 29% increase in Amazon deforestation during the period between August 2015 and July 2016” (Maisonnave, 2017).

Deforestation is one of the biggest concerns when it comes to the environmental policies of Jair Bolsonaro, the new elected president of Brazil. According to the National Institute of Space Research the deforestation rate in the Amazon grew 30% in the period from August 1, 2018 to July 31 2019, going from 7,536 km^2 to 9,762 km^2. This is the third largest growth in history, losing only to 1995 (95%) and 1998 (31%) (Farias, 2019b). However, from january to may 2019, the number of fines for illegal deforestation issued by the Ibama was the lowest in 11 years, decreasing in 34%, which shows a clear relaxation in the control (Trigueiro, 2019).

Figure 5: Annual rates of legal deforestation in the Amazon (km2 / year) - 1994 - 2018



Source: (ISA, 2019)

Impacts

Direct impacts from deforestation include not only a loss in biodiversity but also the loss of environmental services. Brazil´s Amazonian forest plays a huge role “in storing carbon and thus

avoiding global warming (…), in recycling water provides atmospheric water vapour that is important for rainfall not only in Amazonia but also in non-Amazonian areas such as Sao Paulo (…) and in maintaining biodiversity" (Fearnside 2017). Deforestation brings not only these environmental services at risk, but also provoke large GHG emissions and resource degradation.

Affected Cities

Cities are indirectly affected in the sense that environmental services will be lost as long as deforestation remains at the present high levels. Moreover, ecotourism will decrease entailing economic losses for the population.

Stakeholder Perception

National and international agents perceive land degradation and deforestation in Brazil as a risk to human wellbeing and the ecosystem and highlight the importance to introduce mitigation actions. An extensive academic literature on this topic highlights the challenges as well as impacts in the country. International organizations as well as non-governmental organizations point to the negative effects land degradation and deforestation entails on its environment. National authorities introduced various binding and non-binding initiatives. Most studies discuss the effects deforestation has on the discharge of carbon dioxide on a local, national and global level.

4.6 Waste Generation and Management

Brief description

Waste production has increased substantially throughout the last two decades in Brazil. According to the National Sanitation Information System – Solid Waste (SNIS-RS), each Brazilian generated an average of 1.00 kg of municipal solid waste (MSW) per day in 2015, which multiplied by the the Brazilian population accounts for 71 million tons of MSW generated during the year. The coverage rates of public services for collection of household waste in urban areas for the year 2015 was 98.6% (MMA, 2019). Between 2003 and 2014, the waste produced by households increased at a rate of 29 per cent. Furthermore, not the mere production of waste represents a problem, but also its management and disposal. Around 40% of Brazil´s population does not have access to adequate waste treatment services. Moreover, more than 20 million Brazilians do not have access to propoer waste collection services (Flueckiger, 2015).

According to the Panorama of Solid Waste in Brazil - 2017, prepared by the Brazilian Association of Public Cleaning and Special Waste Companies (Abrelpe 2019), 40.9% of the collected waste was dumped in inappropriate places by 3,352 Brazilian municipalities in 2017, totaling more than 29 million tons of waste in dumpsters or controlled landfills, which do not have the necessary systems and measures to protect the environment from damage and degradation, with direct damage to the health of millions of people and significant impacts on public budgets. As the collection coverage rate in the country was only 91.2%, 6.9 million tons of waste that was not collected and, consequently, was improperly disposed of was added to this amount (MMA, 2019).

When comparing the dry and organic recyclable fractions present in the composition of household waste, it is observed that the largest contribution belongs to the organic fraction (50%). In the fraction of dry recyclables (50%) from urban solid waste (USW), it is possible to see the greater participation of plastics (45%), followed by the paper/cardboard fraction (33%), glass (11%) and metals (11%) (MMA, 2019). At present, only 30% of dry recyclables is actually recycled.

Nevertheless, important progress has been done regarding recycling. While in 2010 around 58 per cent of all cities had implemented recycling mechanisms, in 2014, already 65 per cent of urban settlements put into effect recycling procedures. Brazil became one of the world´s leading parties in recycling aluminium. In 2016, for instance, Brazil recycled 280,000 tons of the 286,000 tons produced aluminium cans for beverages (Waste Expo Brazil, 2018).

Impacts

The increase in waste production as well as inadequate waste management have lead to an increase in water, soil and air pollution, GHG emissions, and risks to human health . A study from the Brazilian Association of Public Cleaning and Special Waste Companies (Abrelpe) states that the country spends R$3 billion a year on health care services for people who was exposed to the pollution cause by waste. The inappropriate disposal of waste can result in a variety of environmental problems, such as water, soil and even air pollution. Thus, the existence of dumpsters directly affects the health of 95 million people, whether they live in the vicinity of these dumps, or consume either the water or the food produced in these areas, bringing a series of health problems (Bast, 2018).

Furthermore, it is estimated that 80% of the waste found in the oceans originates from activities carried out on land (inadequate management of solid waste, tourism, industry, among others). In Brazil, along 8,500 km of coastline, there are 274 coastal municipalities facing the sea. Nevertheless, only half of the them, 153 (55.8%), had a Municipal Plan for Integrated Management of Solid Waste in 2017, and only 61 had implemented selective collection programmes in 2016 (MMA, 2019).

Affected Cities

Almost half of the 5,570 Brazilian cities do not currently have an integrated waste management plan. The Brazilian Institute of Geography and Statistics (IBGE), in a study counducted in 2018, pointed out that the existence of a plan is more frequent in the most populated cities. In municipalities with more than 500,000 inhabitants, 83.3% have a waste management plan. In those between 5,001 and 10,000 inhabitants, only 49.1% (Bast, 2018).

Moreover, solid waste generation is growing faster than the population rate, meaning that waste production per citizen increases. In 2015, for example, only 72.5 per cent of urban households had access to all three basic types of sanitation services, including sewage treatment, waste collection and potable water (Bello, 2018). This indicates a lack of access of around 18.7 million household to at least one of these three services.

Stakeholder Perception

National and international agents perceive waste generation in Brazil as a risk to human wellbeing and the ecosystem and highlight the importance to introduce mitigation actions. In recent years there has been a quantitative and qualitative improvement in the coverage of garbage collection in Brazil. The advance, however, was much less than necessary: there is a large contingent of people not served by collection services, and the sector presents considerable deficits in relation to selective collection, recovery of materials and disposal of solid waste (Abrelpe, 2019). According to the Environment Ministry the biggest main obstacle to adequate municipal solid waste treatment is the lack of resources of the municipalities and suggests measures such as the introduction of a waste tax, and the grouping of cities into consortia to share the costs (Bast, 2018).

4.7 Summary

Having elaborated the challenges above, the following conclusions can be drawn:

- The most important environmental challenges dicussed in Brazil entail air pollution, climate change and deforestation; and to a slightly lesser degree, water pollution and waste generation.
- In particular deforestation through settlement and extension of pasture and the related carbon dioxide discharging effect represents a huge challenge on a national as well as on a global scale which is widely discussed by the academic literature, all kinds of media as well as national and international authorities.

In the following Table 5, the challenges discussed above are summarized and evaluated.

Table 5: Summary of extent of environmental challenges at the urban level in Brazil

Environmental challenge	Main drivers	Significance of challenge
Air pollution	Population increase, Industrial activities, transport, waste production and collection	Very high: All stakeholders discuss it, all urban settlements are affected
Climate change	Population increase, Industrial activities, transport, deforestation, waste production and collection, inappropriate infrastructure	Very high: All stakeholders discuss it, urban settlements are responsible for an important share of GHG emissions; low-income population will be strongly affected; coastal cities will be especially affected by the rising sea level.
Water pollution	Industrial activities, agricultural activities using large amounts of pesticides and herbicides, monocultures, inadequate water distribution systems	High: All stakeholders discuss it; mitigation actions with regards to waste collection infrastructure in surface waters are often not effective
Loss of biodiversity	Deforestation, agricultural activities, inadequate land tenure rights/land ownership	Medium to low: the impact of urban settlements on biodiversity is mostly indirect and is related to urban sprawl / growth (gated communities, informal settlements), as well as the use of natural resources such as water
Land degradation and deforestation	Agricultural activities in particular monocultures, industrial activities such as mining, development of infrastructure	Medium: the impact of urban settlements on land degradation is mostly indirect as the main driver of it in Brazil is agriculture. However, unsustainable consumption paterns of urban residents do play a role in it
Waste generation and management	Increased per capita solid waste production, ineffective waste management mechanisms	Very high: Waste generation and management in urban areas is discussed widely as an important

Environmental challenge	Main drivers	Significance of challenge
		challenge.

Source: Own compilation, Wuppertal Institute

5 Urban environmental challenges in Russia

This section describes challenges of urban environmental protection in Russia, following a similar structure as in the previous chapter.

5.1 Air pollution

Brief description

Russia is a very unevenly populated country so the air quality varies greatly from region to region, with the major differences coming between urban and rural areas. Among urban areas the major split is between cities which have transport as the main source of air pollution and the cities which have a combination of factors (coal-based electricity and heat generation, industrial production facilities, transport). Moscow, St. Petersburg and other major non-industrial cities of the European part of Russia (which also have natural gas as their major source of electricity and heating generation) usually fall in the first category, while still industrialised cities of the Ural and Southern Siberia regions (with higher shares of coal generation) - into the second one.

Overall, the level of pollution from the stationary pollution sources (e.g. industrial pollution) has been gradually going down in the years following the breakup of the Soviet Union, however, in the last ten years it has stayed at the same level (Report on the Ecological Development of the Russian Federation in the Interests of the Future Generations, 2016). On the other hand, the level of pollution from the transport/mobility sector is slowly growing in urban areas with a few contradicting trends taking place at the same time -- on one hand, the amount of cars is increasing, on the other hand, the fleet of cars is being gradually renewed and the environmental requirements for the quality of transport fuels are also being introduced (at a slow pace). According to the Autostat analytical agency as of 1.1.2018 out of the 42.4 mln of passenger vehicles 27% had Euro-0 standard, 4.4% - Euro-1, 12.2% - Euro-2, 14.6% Euro-3, 28.7% - Euro-4 and 13% - Euro-5. Overall in the country more than two thirds of all vehicles do not have their emission class (standard) mentioned in their registration documents (Autostat 2018).

Open (or improperly managed) waste landfills around urban area (for example, Moscow), coal opencasts (mainly Ural of Southern Siberia), open handling of coal in port cities (mainly the Far East of Russia), lack of proper management or depreciation of the wastewater treatment facilities also contribute to air pollution in various urban areas across Russia.

Lastly, forest fires in Southern Siberia and in the Far East of Russia also act as the source of air pollution for the urban areas in affected regions. In 2010 when the forest (and peat fires) were also spreading across central Russia the smog coming from them also had an effect on the air pollution in Moscow (causing up to 11 000 additional deaths, B. Revich, 2010). The wildfires in Siberia in summer of 2019 have also brought smog for many weeks to a number of Siberian cities (including Krasnoyarsk).

Impacts

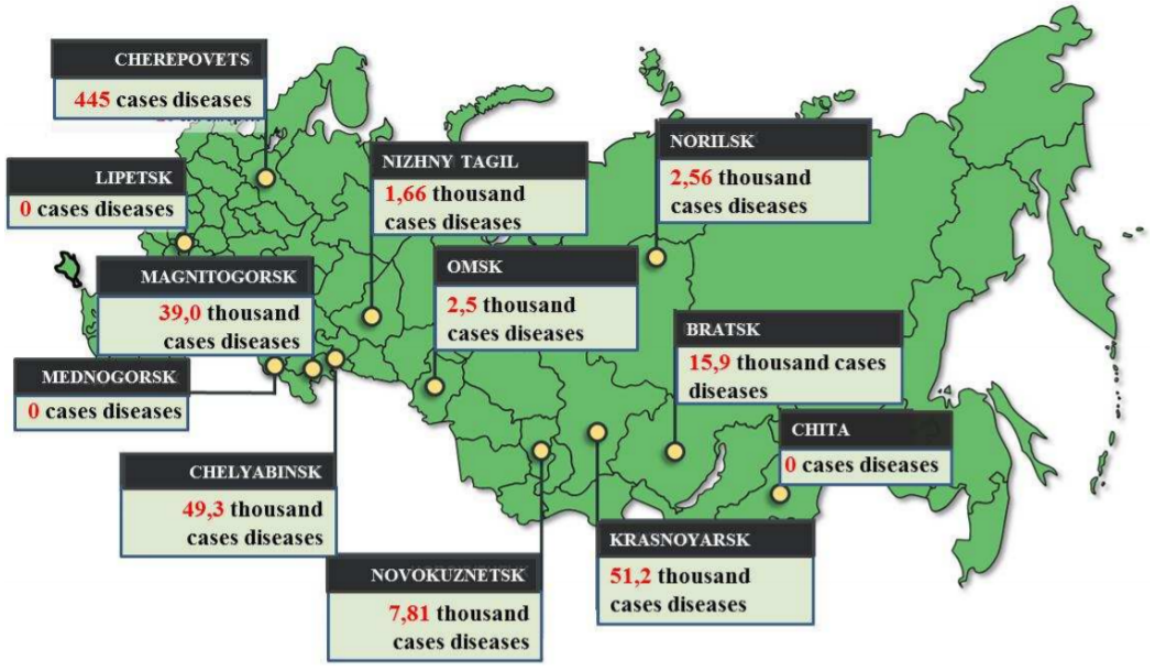
Air pollution is considered to be an important issue for Russia's federal and regional policies. Policy makers/authorities regularly speak of it as a major challenge and threat to sustainable development, well-being and quality of life of Russian citizens. The recent presidential decree "On national goals and strategic tasks for the development of Russian Federation till 2024" (May, 2018) lists 'radical decrease of the air pollution levels in industrial urban centres of the country' as one of the main priorities.

More than 50% of urban population (50.7 mln people) live in the cities with high or very high level of air pollution (Report on the Ecological Development of the Russian Federation in the Interests of the Future Generations, 2016).

The Accounts Chamber (2020) published a report, which analyses the results of the implementation of the national project "Ecology", stating that almost 40% of the population of Russia breath polluted air. This is equivalent to 56 million people from 143 cities whose health is at risk. The content of harmful impurities continues to grow, especially in the Asian part of Russia: air pollution causes around 7% of deaths of lung cancer, 18% of lung diseases, 20% of stroke and 34% of cardiovascular diseases (Accounts Chamber 2020).

The twelfth most polluted cities in Russia are mostly located in the Ural or the Siberian region and include Bratsk, Krasnoyarsk, Lipetsk, Magnitogorsk, Mednogorsk, Nizhny Tagil, Novokuznetsk, Norilsk, Omsk, Chelyabinsk, Cherepovets and Chita. Figure 6 shows the absolute number of diseases that are associated with air pollution in the cities.

Figure 6: Absolute number of diseases associated with air pollution in 2019



Source: Kleyn et al. 2020

According to various estimates, air pollution causes between 80,000 and 140,000 preliminary deaths. (Shaposhnikov et al. 2014, B. Revich 2017), which makes up till 5-7% of the overall mortality. 5000 till 7000 extra deaths in Moscow are caused by the air pollution (Revich et al. 2016). 67.9 thousand additional deaths are attributable to particulate matter annually (Revich et al. 2017).

Affected cities

Urban air pollution is a national problem across most urban areas in Russia. In the European part of the country Moscow, St. Petersburg, Nizhny Novgorod, Ekaterinburg, Kazan, Rostov on Don and Krasnodar are the cities where air is mostly polluted from the transport sector. In the Ural and Siberian regions the cities of Krasnoyarsk, Chelyabinsk, Chita, Kemerovo are highly affected by the coal generation and industrial (processing, metal, chemical, etc sectors) production. Barnaul, Bratsk, Irkutsk, Krasnoyarsk, Magnitogorsk, Novokuznetsk, Norilsk are

listed among the most polluted cities in Russia (Roshydromet, 2017, overall 21 cities with around 5 mln inhabitants).

Stakeholder perception

All stakeholder groups perceive and frame air pollution as a major challenge for Russian urban areas, including policy maker/authorities at the federal and regional level, researchers, civil society groups/NGOs, national media, and the general public. According to public polls, such as the Russian Ecological Society Study (December 2019), environmental and ecological problems (in particular air and river pollution, but also waste disposal and unauthorized landfills) are ranked 4th among the list of problems that concern the general public (Russian Ecological Society).

A similar study by the Russian Public Opinion Research Centre, published in February 2019, states that „among the most acute environmental problems, respondents cite air pollution (22%), landfills (16%), dirty rivers and lakes (13%), untimely garbage collection (11%), poor quality of tap water and problems with parks and forests (6% each)“ (Russian Public Opinion Research Centre 2019).

Air pollution is one of the major topics for grass root civil society movements in Russia over the last few years (both in industrialised urban areas and in non-industrialised urban areas, like in Moscow, where people often hear smells from landfills, wastewater treatment plants or incinerators). The access to environmental information about the quality of air in urban areas is also limited. It is very often either not accessible to the public, or it is difficult to understand and interpret, or it does not look trustworthy.

5.2 Climate Change and its effects

Brief description on drivers and causes

The Russian Federation is the world's fifth largest greenhouse gas emitter, with 2.6 billion tons of CO2 equivalent emitted in 2016 (most recent reporting year; UNFCCC 2018). Russia's emissions have been relatively stable since 2009 (UNFCCC 2018). The primary GHG emissions driver for Russia is the energy sector, which amounted to 83% in 2015 (Analytical Center 2017, Fedorov 2017). 17% of total emissions in 2015 came from transport, and a further 22% were from housing and buildings (Fedorov 2017) – the two factors that are particularly relevant for cities.

Impacts

Roshydromet estimates that the global warming trend is more pronounced in Russia, since the temperature increase in 1976-2016 was 0.45C per decade, 2.5 times higher than the global average, and this trend is expected to continue throughout the 21st century (Roshydromet Climate Centre 2017). With 74.3% of Russians living in cities (The Demographic Yearbook of Russia, 2017), climate change impacts in urban areas will have a profound effect on the population.

Extreme weather events are a major concern high on the national list of priorities after the 2010 summer heatwave in the Moscow region, estimated to result in over 54 thousand premature deaths (Revich et al. 2011), and catastrophic flooding in the southern town of Krymsk in 2012, with over 170 people dead and 13,000 affected by property damage (RT 2012). Both events have been linked to climate change (Rahmstorf et al 2011, Meredith et al 2015). Heatwaves have also been shown to significantly increase mortality in major cities of the Russian south such as Krasnodar and Volgograd (Revich et al. 2015), whereas extreme cold spells constitute a more substantial risk for northern cities such as Murmansk and Yakutsk (Revich et al. 2010).

Estimates suggest that even a small 0.5% increase in the contribution of the climate factor to morbidity and mortality in 2020-2030 will lead to human life losses that are associated with a 0.3% GDP loss (Roshydromet 2017).

Apart from the loss of life, these weather extremes carry significant risks to electric grid infrastructure (Serov et al 2016; Roshydromet 2017) as well as to buildings and structures throughout Russia (Akimov et al 2016). Increased temperature variability in the winter may also cause damage to buildings (Roshydromet 2011, Roshydromet 2014) and transport infrastructure (Roshydromet 2017). Rising summer temperatures will also lead to overheating issues in older buildings and increased costs of air conditioning as well as additional pressure on the electric grid (Roshydromet 2017).

According to the report of the Accounts Chamber (2020), discussing the project outcomes of "Ecology", climate change leads not only to droughts in agricultural areas but also the melting of permafrost, which brings the infrastructure at risk. Taking the 1970s as a baseline, the bearing capacity of soils in the permafrost zone decreased on average by 17%, while in some areas – it decreased by around 45%. The statistics of the joint venture show that as a consequence, dangerous deformations affect railway, automobile and pipeline facilities. The cost of damage from climatic phenomena up until 2030 is estimated to cost around 2-3% of GDP per year, and in some territories - 5-6% of the gross regional product. In monetary terms, over a period of ten years, this adds up to an amount of 34 trillion roubles (in 2019 GDP prices, $553 bln) (Accounts Chamber, 2020).

Sea level rise and coastal erosion are a specific concern for Saint Petersburg, Russia's second largest city (Roshydromet 2014). Spring floods are also expected to become more powerful in central and eastern Siberia, while southern Russia and the southern Far East will experience more flash floods (Roshydromet 2011; Roshydromet 2014). The most recent catastrophic flooding in the Amur river region in 2013 resulted in 527 billion roubles (approx. $8.4 billion) in damages (Roshydromet Climate Centre 2017).

The European part of Russia is home to 80% of the country's population but has just 21% of the total freshwater resources, with freshwater reserves much lower than in the Asian part of the country (Roshydromet 2017). This makes freshwater availability in a changing climate an increasing concern, especially in the Volga, Oka, Klyazma and Ural river regions (Roshydromet 2014; Roshydromet 2017). Water shortages are also more likely in the Russian south (Roshydromet 2011; Roshydromet 2014).

Due to increasing soil temperatures and melting permafrost (Streletskiy et al. 2014), especially on the southern Arctic border, buildings and transport infrastructure are also at risk, with widespread damage more pronounced in the recent decades (Streletskiy et al. 2012). Central and western Siberia, Yakutia and Chukotka are among the regions most affected by permafrost degradation (Roshydromet 2017).

Wildfires, including ones threatening settlements, are expected to become more common in the central and Ural region and Siberia (Akimov et al 2016), with the average length of wildfire season increasing by up to, at the most extreme, 30 to 50 days (Roshydromet 2014). Rosleskhoz estimates that annual losses due to forest fires already exceed 20 billion roubles ($317 million), and these are expected to grow as well (Roshydromet 2017).

In 2019, one of the most severe forest fires in the Russian history occurred. The State Forestry Service estimated that the total area burned amounts to around 10.3 million hectares in total. This is equivalent to 1 per cent of forest area in Russia and is associated with economic losses of around 7 billion roubles as well as CO_2 emissions of around 82 million tons. Total CO2 emission

was 284 million tons since the beginning of the year, 1.6 times higher than the average amount (RIA Novosti 2019).

Positive impacts will mainly manifest as shorter (by up to 4-5 days) winter heating periods, but due to inefficiencies in centralized heating systems, these impacts are unlikely to translate into significant economic benefits for the more populated western part of Russia (Roshydromet 2011; Roshydromet 2014).

Affected cities

At 12.5 million inhabitants (Mosgorstat 2018), Moscow is Russia's most populous city and agglomeration. The global megatrends determining sustainability and adaptation needs for European cities (European Environment Agency 2016) are relevant for Moscow as well (Molchanova et al 2017). Saint Petersburg is uniquely vulnerable to coastal impacts, as the lower Neva river region is set to experience more frequent and severe flooding by 2030 and beyond (Roshydromet 2011; Roshydromet 2014). Other affected cities include major population and industrial centres such as Novosibirsk, Yekaterinburg, Nizhny Novgorod, Kazan, Chelyabinsk, Omsk, Samara, Ufa, Krasnoyarsk, Perm, Voronezh and Volgograd (all cities with over 1 million inhabitants).

Arctic cities are a separate category, which includes Murmansk, Norilsk, Vorkuta, Apatity, Salekhard, Novy Urengoy, Noyabrsk, Naryan-Mar, Anadyr, and other smaller settlements. Here the main risks are negative consequences from melting permafrost (and damage to infrastructure), new diseases appearing and changing weather patterns. (Roshydromet 2014).

Stakeholder perception

Government officials frame climate change as a "large-scale challenge and threat" at the international level (Putin 2018) as well as a more local threat to livelihoods and prosperity (Kobylkin 2010). NGOs and civil society frame this issue as both a concern for Russia and an opportunity to shift to a more sustainable development pathway (WWF n.d.). Until recently climate change discourse was largely absent from major Russian media (Poberezhskaya 2014), with scepticism or denialism still widespread among the public (Kokorin 2017), however in the last three years and especially since Russia joining the Paris Agreement in September, 2019, the media coverage of climate change-related risks and threats, also in urban context, has increased significantly. In 2018, for instance, the Moscow Public Opinion Foundation published that around 84 per cent of the Russian population is familiar with the term climate change, while around 66 per cent consider it a risk. More than 50 per cent believe that climate change should be mitigated (Davydova 2019).

5.3 Water pollution

Brief description on drivers and causes

Russia has the world second largest freshwater resources after Brazil (FAO 2017). Still, just like in case of air pollution, following the drop in untreated wastewater discharges after the fall of the Soviet Union, at the moment a big proportion of all surface waters in Russia are being estimated as 'dirty' or 'extremely dirty" (Report on the Ecological Development of the Russian Federation in the Interests of the Future Generations, 2016). The volume of discharged contaminated waters continues to decrease, yet the amount of high and extremely high pollution cases of surface waters remains to be at more or less the same level over the last 10 years (around 3000 cases per year). Around 15% of all water used for centralised water supplies does not comply with the state sanitary and hygienic requirements (due to untreated industrial, agricultural and municipal discharges). 7% of the country population (5% of the urban

population) are not supplied with the quality water (meeting sanitary and hygienic requirements). According to the Federal Action Program "Water of Russia", in 2015 overall in the country only 11% of all wastewaters were properly cleaned up, the 19% were not purified at all, and the remaining 70% were not treated according to the state requirements.

60% of urban population are covered with water supply treatment systems and 84% of city dwellings are equipped with sewage facilities (Federal Action Program "Water of Russia", 2016). According to the report of the Accounts Chamber (2020), which analyses the results of the implementation of the national project "Ecology",88 per cent of untreated wastewater is emitted into rivers. Simultaneously, there are no sewage treatment facilities available for around 95 per cent of rural settlements. "Ecology" is an important policy instrument in Russia's environmental approach and has the overall goal to improve Russia's environmental protection by 2024 with regard to ten main fields of action: Liquidation of illegal landfills, integration of the system of municipal waste management, improving infrastructure for hazardous waste, improve air and water quality, in particular the Volga river, and preserving unique water objects, forests and biodiverse areas (Bakunovich 2018).

The main sources of water pollution are industrial discharges (often illegal), agricultural runoffs, municipal sewage systems often lacking wastewater treatment facilities, dilapidated water supply infrastructure.

An increased use of household chemical over the last few years also contributes to eutrophication of rivers and lakes. Extensive use of phosphate-based cleaning products by the local households and growing tourist infrastructure with the absent wastewater treatment facilities has been named as one of the main causes of environmental problems of the world largest freshwater lake (by volume) – lake Baikal, located in Southern Siberia. The micro plastic pollution is also on the rise (no nation-wide study on the micro plastic has been carried out yet). The Institute of Lake Science of the Russian Academy of Sciences and the Russian State Hydrometeorological University (2019) have published a study which states that the beaches and ponds of the North-West of Russia are polluted almost everywhere. For each liter of water from Lake Ladoga (Russia's second largest lake after Lake Baikal) and its tributaries, there is one microplastic particle from 1 micron to 5 mm in size.

Impacts

Poor water quality is a problem for most Russian cities, especially small and medium-sized ones. In recent years municipal water companies of Moscow and St. Petersburg (and a few other cities) have been extensively renovated with new purification and treatment equipment installed (which in case of St. Petersburg has significantly contributed to lesser contaminated discharges getting into the Gulf of Finland and later into the Baltic Sea). Still aging water infrastructure poses great challenge for the future of water supplies (and wastewater treatment) in many cities of Russia. Municipal water companies should also comply with the new Best Available Technologies legislation (see the Air Pollution section for further details), but in most cases it is the lack of financing which prevents from further modernisation of the water utility companies in urban areas.

Affected cities

Moscow and St. Petersburg provide the largest amounts of non-treated wastewater into natural water reservoirs (rivers, lakes, etc). Further cities producing large amounts of (often untreated) wastewater include Krasnoyarsk, Volgograd, Nizhny Novgorod, Chelyabinsk, Kazan, Ekaterinburg, etc (Report "On the state and management of environment in Russia in 2016").

Stakeholder perception

Federal regional policy makers/authorities, municipal utility companies, researchers, NGOs/civil society groups perceive water pollution as a challenge. According to popular polls, water pollution remains to be a worrying issue for many Russians, yet, contrary to the air pollution, there are very few public campaigns or also NGOs/civil society groups working with a water pollution problem. The official data on the quality of water is often not publicly accessible.

5.4 Noise pollution

Brief description on drivers and causes

The increased amount and use of private cars, intensive new construction and enlargement of urban areas are the main causes of the high level of noise pollution in large cities across Russia. The main sources for noise pollution in Moscow are cars and other motor vehicles, railroad trains, over ground metro networks, planes, electricity and heat generation facilities, construction equipment (and construction works).

Impacts

The level of noise pollution has increased by 2.5 times over the last 20-25 years. 37% of the Moscow population, 60% of the population of St. Petersburg and 20% of the Perm population live on the territories with the noise level above the norms, next to the highways (B. Revich, 2017). Up till 70% of the Moscow territory are under noise pollution from various sources (Moscow City Government Department for Environmental Management and Protection 2017). Rospotrebnadzor (Federal Service for Supervision of Consumer Rights Protection and Human Well-Being) reported that it registered more than 24,000 complaints about noise in 2017 in cities across Russia.

Affected cities

Noise pollution is mostly acute for large cities across Russia (mostly the ones with the population above 1 mln inhabitants), but also for smaller settlements around these large cities, adjacent to highways and motorways.

Stakeholder perception

Noise pollution doesn't play a very important role in public agenda, the level of awareness about this particular problem remains to be low, even though according to popular polls up till 40% of Moscow residents complain about the noise levels.

The topic is also not highly present within the political agenda and among government officials. On the city level, local administration rarely mentions it as one the most urgent urban/environmental issues. The city of Moscow is one of the few exceptions, the city Department for Environmental Management and Protection lists the problem high in their priorities on their website and annual reports and tries to work out the measures to bring the noise pollution level down.

The problem got into wider public opinion only in May 2018, with the Civic Chamber in Russia originating a discussion about noise pollution, a need for further stricter regulation, including reforming the legislation. The Chamber has also suggested that a noise map for the cities of Russia with the population above 100 000 people should be developed.

5.5 Urban green space and spatial planning

Brief description

Current trends of urban development and planning in Russia determine a number of issues related to green spaces and sustainable planning in Russian cities, especially the largest ones, such as Moscow, Saint Petersburg and other cities with population above 1 mln inhabitants. Major issues in this field are:

- decrease in overall surface of green spaces due to intense residential construction both on the territory of green spaces within the existing urban fabric and on the periphery of cities;
- fragmentation of green and blue urban fabric due to residential construction and urban infrastructure projects, especially transportation (Alexander Vodyanik 2016);
- suburbanisation and urban sprawl as consequences of lack of regulation of real estate development and obsolete, single-use and car-oriented approach to territorial planning;
- reduction of per capita surface of accessible green spaces due to decrease in overall surface and population growth in largest cities (Greenpeace Moscow 2016);
- decrease of overall biodiversity and quality of urban green spaces due to fragmentation of spaces, selective destruction of the most valuable urban ecosystems such as urban forests, and increased user pressure (ONF Year of Ecology Report, 2017).

These negative trends, with some deviations, are also observed in smaller cities and towns throughout the country, especially in industrial ones. Urban green spaces are one of important issues of Russia's urban development policy that attracts considerable public attention; however, no significant changes in actual implementation of urban policy currently happen due to conflict of interests of different stakeholders and lack of transparency and accountability in the decision making.

Impacts

Reduction in quantity and quality of green urban spaces goes hand in hand with urban sprawl, and has direct consequences on urban environment quality, especially in terms of air quality, and, subsequently, on public health, including occurrence of respiratory diseases and level of stress among inhabitants. Most real estate projects developed both on territory of former parks or other green zones within cities, or on vacant lots on their outskirts, appear as high-rise, high-density districts with little or no greenery, rather than townhouses, which further decreases the average surface of green zones per inhabitant and puts a strain both on transportation and on green infrastructure of cities.

Other ecosystems services provided by green spaces including the reduction of extreme heat, precipitations retention and prevention of floods also come under threat with such extensive and expansive urban development. Consequences of deterioration of green urban infrastructure are particularly important in coastal and mountainous cities such as the city-resort of Sochi, where the evidence of floods and landslides, caused by destruction of vegetal zones during the construction of Olympic Games infrastructure and subsequent unregulated real estate development in the adjacent zones, has been presented.

In social aspect, disappearance of green spaces is a major source of public discontent with local authorities, and a sensitive issue for local politics. However, examples of public officials resignation or cancellation of controversial urban projects because of strong public opinion about urban ecology issues as such are rare (but are still taking place), while cases of public officials resignation or cancellation of controversial industrial/energy projects (new coal plant, coal harbour, polluting factory) are more frequent. Moreover, urban planning policy is often designed for commercial projects, while local resistance by the population to the reduction of

green spaces has only minimal impact on the local authorities. (Eurasianet 2019). The standard norm of green zone per capita that is recommended by the World Health Organization is 50 square meters per inhabitant which in turn translates into a 40-60 per cent requirement of green area in urban areas. In Moscow, there is a 5 square requirement per inhabitant next to the buildings in place and a 50 square meters requirement per person for the entire city. However, these requirements are often not considered during construction, non-compliance is not further pursued, and green spaces are converted into commercial or residential areas. One reason for this is that urban green zones are object of three types of laws, including environmental, land and urban planning regulations. Legal uncertainty with regards to green spaces is created through the large contradiction among these laws (Eurasianet 2019).

On the other hand, quality of urban green zones has certain influence over the cities long-term development and demography. Accessible green zones with high recreational value contribute to overall perception of attractivity of cities, which is very low in small and mid-sized town compared to big cities. Therefore, this factor also has certain influence on the population drain from smaller, less attractive cities and towns to larger ones, especially among young people and young families (Kashnitsky at al., 2016).

Affected cities

Comprehensive analysis of the condition of urban green spaces is only available for several major cities in Russia, including Moscow, Saint Petersburg, Rostov-on-Don, Kazan and several others. For these cities, the main driver of deterioration of urban green spaces is the intense construction of transport infrastructure (highways and parking), as well as new high-density, poorly vegetal residential districts on the territory of existing urban parks within the cities and on green fields in their outskirts (Expert.Ru 2016; Thenatureofcities.com 2013; Greenpeace 2016).

Condition of green spaces in other Russian cities can be estimated according to the Urban Environment Quality Index developed by Strelka Institute and published by Russian Ministry of Construction in 2017 (Urban Environmental Quality Index 2018). Analysis provided in the Index demonstrates that largest cities are still better ranked in terms of total amount and quality of green spaces compared to mid-sized industrial cities, with some notable exceptions such as Samara and Volgograd (6 and 8 Green spaces points out of 50, respectively). Recent reports also show the degradation of forests adjacent to smaller towns throughout Russia that “compensate” the deficit of intra-urban green spaces, due to pollution, land misuse, illegal cuts and landfills, and other factors (ONF Year of Ecology Report 2017). Also, a recent and widely mediatized series of rallies in several cities and towns in Moscow region, whose inhabitants protested against the air pollution caused by illegal landfills, can be considered as a consequence of notable policy failure in respect of sustainable territorial development.

Stakeholder perception

The issue of urban green spaces management is addressed by many stakeholders at different levels. At the national level, major stakeholders include the government (Ministries of Construction and of Natural resources and ecology), state-owned and private expert organizations in charge of development of rules and standards of urban space management (such as Research and Project Development Institute of General Planning or Strelka Institute), law enforcement structures, and also civic structures (such as the Civic chamber of Russian Federation or All-Russia Popular Front) and influential NGOs, such as Greenpeace. Regional and local level stakeholders include municipal authorities and authorities at level of “region-city” for Moscow, Saint Petersburg and Sevastopol, real estate development and construction companies,

deputies of urban and municipal councils, experts networks, media, local non-governmental organizations and citizen communities.

Perception of urban green spaces issue by national level stakeholders is mostly viewed as part of the national policy of urban development, one of the top current priorities of national development that is being implemented by the government of Russia (Presidential decree № 204, May 7, 2018). Civic structures involved in monitoring of public opinion on different issues, including the environmental problems in cities, serve as channels of bottom-up communication between the government and local citizens and usually side with the population, but have relatively little leverage on the issues in specific regions.

On regional or local levels, where the actual urban development plans and local regulations are being developed and implemented, the conflict of different stakeholders is even more evident, especially since the end of the first decade of 2000s when a series of campaigns against unsustainable urban projects in Moscow and several other cities swept through the country. Regional administrations and local councils usually tend to find compromise between interests of regional industrialists or real estate developers that rarely integrate urban ecology or landscape planning clauses into their projects, and local communities of inhabitants that usually have a very protective stance towards their environment and negative attitude towards real estate developers and authorities that side with them. Networks of local experts in urban planning and urban ecology that usually collaborate with local parliamentarians and activists, often function as intermediaries in negotiations. They usually defend ecological interests of local communities, while taking into consideration the positions of other stakeholders.

5.6 Waste generation and management

Brief description and impacts

Waste is one of the largest and often perceived as the most important and urgent environmental problem in Russia. By the end of 2016 more than 40 bln tons of waste have been accumulated in the country. Yearly around 5 bln tons of waste is being generated (out of which 200-300 mln tons are municipal solid waste). Only 5% to 10% of all waste is being recycled, the rest is incinerated or buried in landfills (up till 90%). There are six incinerators for the municipal solid waste working at the moment in Russia (three in Moscow, and one per city in Vladivostok, Murmansk and Pyatigorsk). Most of the incinerators were built in the 20th century, they do not satisfy the current requirements of environmental protection legislation. There are massive public protest campaigns against the construction of new waste incinerators in large cities, while also against the corrupted systems of landfill management, landfills being overfilled or not properly managed (mostly in the Moscow region and in a few further densely populated regions in central Russia).

Around 858 million cubic meters of methane (equivalent to approximately 2.5 million CO2 tons) are emitted by the 858 largest landfills, where around 24.6 million tons of waste is buried per year. Considering the results of the national project “Ecology”, landfills cover a total area of 4 million hectares, rising by 300-400 thousand hectares annually. 17 million people live in close proximity to 340 of these landfills (Accounts Chamber, 2020).

The waste (mostly landfill) sector is often vulnerable to corruption and fraud (including illicit enrichment of local authorities engaged in contracts with the businesses running the landfills), and in some regions is even connected to organised crime and further crime rings.

Affected cities

The waste problem is present in most of densely populated regions of Russia, with areas around largest cities being the most vulnerable to the issue.

One of trouble spots over the last few years has been the Moscow region (i.e. the region around Moscow, not including the city) which has to process its own waste + the waste generated in Moscow (up till one fifth of all municipal solid waste in Russia), since Moscow as a city (and also one of the three regions along with St. Petersburg and Sevastopol) is not allowed to have landfills on its territory. Most of official landfills of the Moscow region have already overcome their capacity, but since there are no new ones being built (also due to the public protests and intensive housing construction in the region), they're still being used and over fulfilled which generates a number of further environmental problems (including emissions of landfill gases and odours, contamination of ground waters, etc.). There are also many non-registered or unauthorised landfills all over the country.

Stakeholder perception

Federal regional policy makers/authorities, business representatives, researchers, NGOs/civil society groups perceive waste generation as the most urgent environmental problem in Russia. Among general public this challenge is also listed among the three most important environmental problems (dependant on the region) along with the air and water pollution.

Authorities often speak about the waste generation problem is the most acute both on the federal and regional level. The topic is also very popular with the civil society groups which engage in grass root recycling initiatives, fight against plans to construct new waste incineration facilities, organize campaigns around improper management of landfills (including their overfill or plans to create new ones), track unauthorised landfills and raise public awareness to the problem, try to hold regional authorities accountable for the waste management issues, support waste reduction and recycling, etc.

5.7 Summary

Based on the above analysis, the following conclusions can be drawn:

- The most prominent themes in the context of urban environmental protection discussed in the country and about the country are waste generation, air and water pollution, urban green spaces and spatial planning. Climate change is becoming more of an important topic, although the impacts of climate change are more focused on than climate change mitigation, which plays a minor role. Noise pollution is still an emerging issue.
- Increasing urbanisation (including further housing/infrastructure construction, rising use of motor vehicles, demolition of green areas) is the main cause of the environmental damage caused.
- Urban areas also contribute to environmental damage in non-urban areas (that is especially the case of Moscow), through waste generation on landfills located in non-urban areas or water pollution resulting from non-treated or not sufficiently treated wastewater
- Non-urban areas hardly contribute to environmental challenges in cities. However, for instance, the burning forests or peats can affect air quality in cities.

The following table summarises the conclusions, employing the five categories to evaluate environmental challenges at the urban level as developed in the methodology section.

Table 6: Summary of extent of environmental challenges at the urban level in Russia

Environmental challenge	Main drivers	Significance of challenge
Air pollution	Transport, Energy generation, Industrial pollution, Waste, Forest and Peat fires	Very high: all stakeholders discuss it, most urbanised areas are affected, clean air is a political priority for most of urbanised region where industrial production is a main contributor to air pollution, and also for some of the regions where transport is the main cause of air pollution
Climate change and its effects	Energy generation, industrial production, transport, urban sprawl, waste	Medium: some urbanised areas are affected, some stakeholders discuss it, there is still climate scepticism among certain stakeholders towards climate change
Noise pollution	Transport	Low: it is often being mentioned as issue of public concern for residents of urban areas, however, very rarely discussed professionally. So far, experts discussions on the topic have been held only in Moscow and St.Petersburg. There is almost no regulation of the issue.
Water pollution	Water management, water treatment, sewage treatment, housing and public utilities	High: many stakeholders discuss it, most urbanised areas are affected
Urban green spaces/spatial planning	Further urbanisation, intense construction, lack/inadequate environmental regulation of the construction sector, poor implementation of sustainable development principles into urban development strategies, poor involvement of various stakeholders into discussion about future city planning	High: many stakeholders discuss it, mass public protests in various urban regions of the country, growing expert community
Waste generation and management	Waste management, Awareness, Poor involvement of various stakeholders (mainly the general public) into discussions about waste management, construction and management of landfills and incinerators	Very high: all stakeholders discuss waste management issues, all urbanised areas are affected, mass public protests in various regions of the country

Source: Own compilation, Wuppertal Institute

6 Urban environmental challenges in India

This section describes challenges of urban environmental protection in India, following a similar structure as in the previous chapters.

6.1 Air pollution

Brief description on drivers and causes

The intensity of air pollution across Indian cities is high and its rate is alarming. Various reports such as 'The Environment Performance Index 2016', 'The Global Green Economy Index (GGEI) 2016', 'Ambient Air Pollution Database', 'WHO, May 2016', 'Clear the air for children: The impact of air pollution on children UNICEF 2016' and others suggest that India is one of the most polluted countries in the world (Aman, 2017). The most comprehensive air pollution estimates taken from both satellite and Indian ground-level measurements of fine particulate matter (PM2.5) indicate that 99.9% of the Indian population is estimated to live in areas where the World Health Organization (WHO) Air Quality Guideline of 10µg/m3 for PM2.5 was exceeded in 2015 (GBD MAPS Working Group, 2018). A study reveals that 50% of the population living in 45% districts of India is exposed to PM2.5 concentrations, which are above the Indian air quality standard of 40µg/m3. Only 0.06% of the Indian population is breathing safe air according to the WHO air quality guideline (Cause-specific premature death from ambient PM2.5 exposure in India: Estimate adjusted for baseline mortality, 2016). Although the air pollution levels experienced by the Indian population can vary substantially depending on the area in which people live, these levels are unusually high compared with WHO guidelines and Indian standards.

Air pollution in Indian cities is high due to emissions mainly from fuel wood and biomass burning, coal fire plants, burning of crop residue in agriculture fields on a large scale and emission from vehicles especially from diesel transport, brick production chimneys as well as natural sources such as windblown dust. Among various sources of pollution, road dust dominates the particulate inventory in a study carried out by the Indian Institute of Technology (IIT) Kanpur in 2015, followed by vehicles, industry and power plant sources, mainly in Delhi. In the nitrogen oxide inventory, industry leads with more than half of the share followed by vehicles. Considering the seasonal variation in the contribution to air pollution, winter experiences relatively higher contribution from combustion sources, while the contribution of dust is higher during summer. But vehicles are the most consistent and dominant source of pollution throughout the year (Narain, et al., 2016). The main sources of air pollutions are listed and briefly discussed below:

- Residential Biomass (Residential cooking, lighting, heating, and water heating)
- Agricultural residue/crop fires
- Garbage combustion
- Coal based power plants
- Pollution from Industry
- Transportation (Vehicle technology and fuels, and transport mode)
- Diesel generator sets
- Dust (Windblown mineral dust and anthropogenic dust/construction activities)

Impacts

A vast majority of Indian cities is caught in the toxic web as air quality fails to meet health-based standards (CSE, 2016). Air pollution in Indian cities has serious consequences for human health, causing diseases related to lungs and heart. A study shows that about 2.2 million school children in Delhi are growing up with irreversible lung damage from which they will never recover (Aman, 2017) (Ghosal, et al., 2015). Moreover, air pollution exposure contributed to some 1.1 million deaths in India in 2015 (GBD MAPS Working Group, 2018). Total welfare losses due to air pollution in the country amounted to more than $500 billion (8.5% of country's GDP) in the year 2013 (381% increase from 1990) (Aman, 2017). According to the Global Burden of Disease study published in The Lancet, outdoor air pollution caused more than a million premature deaths in India in 2016, whose costs amount to more than USD 800 billion, according to OECD estimates (The Lancet 2016). Additionally, there is a range of other social costs associated with air pollution, such as costs related to pain and suffering, and costs to biodiversity and ecosystems. Some of other economic consequences of air pollution include reduced labour productivity due to lost work days, and less agricultural productivity due to high ozone concentrations and slow plant growth reducing crop yields (Lanzi, et al., 2017). Recently, smog has led to numerous school closures, flight cancellations in Delhi and highway accidents (Biswas, et al., 2017).

Affected cities

The pollution peak in India's capital - Delhi has been extraordinary, 25 times higher than the WHO recommended level. Beside Delhi, air pollution is increasing also in other Indian cities (Lanzi, et al., 2017). The analysis of the Indian Central Pollution Control Board's data since 2002 showed that all major cities in north and central India - Gwalior, Kanpur, Ludhiana, Gwalior and Surat - have recorded higher pollution rise in percentage terms between 2002 and 2014 (Maurya, et al., n.d.). South India (e.g. Chennai, Thiruvananthapuram and Bengaluru) has comparatively better air quality than north and central India. One of the reasons behind a better air quality in South India is the northeast monsoon showers due to which the pollutants have settled down. Due to this monsoon, the moisture from the south is making its way to the north and trapping pollutants (Goswami, 2017).

Stakeholder perception

Stakeholders at the national and international level are highly active in the issues of air pollution in India. Researchers have been carrying out studies on the risk of air pollution as well as methods to mitigate it in India since decades. The articles, videos and frequent news on the effect of air pollution as well as actions to reduce the effect are available in media. Policy makers are formulating various initiatives (at different sectors) to curb the source and effect of air pollution.

6.2 Climate change and its effects

Brief description on drivers and causes

With a global share of India's GHG emissions at 4.1% (the world's third largest GHG emitter after the US and China), the country also faces a major challenge due to climate change. The GHG missions from the energy sector are the highest in India (2,199 $MtCO_2e$, per capita 1.7 tCO_2e), followed by agriculture (627 $MtCO_2e$, per capita 0.48 tCO_2e), industrial processes (193 $MtCO_2e$, per capita 0.15 tCO_2e), land-use change and forestry (123 $MtCO_2e$, per capita 0.09 tCO_2e) and waste (61 $MtCO_2e$, per capita 0.05 tCO_2e). Within the energy sub-sector, GHG emissions from electricity are the highest (1,083 $MtCO_2$, per capita 0.84 tCO_2), followed by

manufacturing/construction (533 $MtCO_2$, per capita 0.41 tCO_2) and transportation (232 $MtCO_2$, per capita 0.18 tCO_2) (WRI-CAIT, 2015). India's power generation is still heavily dependent on coal, 45% of total energy demand and 80% of electricity (Butler, 2018). Urbanisation and economic development are leading to a rapid increase in energy demand in urban areas in India, leading to greater GHG emissions. This increase in GHG emissions and environmental degradation in Indian cities has caused many unusual weather patterns (such as rising temperatures and declined rainfall) and sea level rise, affecting infrastructure, economy and livelihood.

Impacts

The effect of climate change can be observed in many parts of India. The country is getting continuously and rapidly warmer. The highest recorded temperature is increasing almost every year, causing serious health impacts due to heat stroke and heat exhaustion, crop failures and water shortages (Krishnan, 2017). The alarming rate of climate change has affected the seasonal cycle and the regular monsoon pattern, due to which unprecedented and extreme weather events are frequent in India. Some cities experience heavy rainfalls affecting farms and causing floods while others experience extreme droughts (Chauhan, 2017). Many infrastructures are at risk due to these events. Indian cities at coastal areas are also at threat due to the rising sea-level, such as Chennai.

Affected cities

Many cities in India are affected by climate change. Kolkata experienced a deadly heat wave in 2015 with the risk to be repeated in the future (Krishnan, 2017). The frequency of droughts (i.e. water shortage for human, cattle and agriculture consumption) is increasing in several states, such as Bihar, Uttar Pradesh, Karnataka, Telangana, Kerela and Maharashtra (Chauhan, 2017). Some of the Indian districts that are at high risk due to the sea-level rise include Thiruvallur, Chennai, Kanchipuram, Villupuram, Cuddalore, Nagapattinam, Thiruvarur, Thanjavur, Pudukottai, Ramanathapuram, Tuticorin, Tirunelveli and Kanyakumari (The Times of India, 2018).

Stakeholder perception

Stakeholders at the national and international level are highly active in the issues of climate change in India. Policy makers are formulating various initiatives (at different sectors) to curb the source and effect of climate change. The prime minister, federal ministries, the parliament, expert groups, as well as the business sector, civil society, research institutes and international organisations are involved in India's national climate policy making (Beermann, et al., 2016). The National Action plan for Climate Change and the State Action Plan for Climate Change – issued by the national and state governments, respectively, develop climate change mitigation and adaptation policies, plans and actions at various levels.

Researchers have been carrying out studies on the risk as well as mitigation and adaptation to climate change in India since decades. Niti Aayog – a policy think tank of the Government of India, provides advice and encourages partnerships between key stakeholders and national and international think tanks, as well as educational and policy research institutes. Environmental non-governmental organizations (NGOs) in India, such as Centre for Science and Environment, are active in research advocacy, creating awareness and trainings to address climate change. The articles, videos and frequent news on the effect of climate changes as well as actions to reduce the effect are available in media.

6.3 Water pollution and availability

Brief description on drivers and causes

India faces problems of both water pollution and water scarcity. As India is shifting towards growing economy and population, competing demands over the limited resources of water from households, industry, and agriculture is alarming. Over-extraction of ground water by farmers, industries and households has imbalanced water availability. Besides that, India has insufficient clean water per person due to its population growth (NBR, 2013). Per capita annual water availability decreased from 1816 cubic metre in 2001 to 1544 cubic metre in 2011 (Lahiry, 2017). Rivers in India (such as Ganges, Yamuna and Kaveri) are of poor quality due to the flow of untreated urban water (sewage, industrial waste), largely unfit for drinking and bathing. The World Health Organization estimates that more than 90 million Indians lack access to safe water and 21% of communicable diseases in India are related to unsafe water (NBR, 2013).

Impacts

Rivers in India, such as Ganges which is a great source of water and flows through 11 states of India, are unfit for use due to pollution. Arsenic is also a major problem, especially for people residing in the river belt. Arsenic laden polluted water has many negative health effects and affects over 900 million people in India (Dutta, 2017). As India's rivers are getting polluted, the dependency on groundwater resources is growing – which is also facing the risk of getting dried. In many municipalities, water supply for households is not enough and citizens have to buy water privately in tankers.

Affected cities

Many large cities are moving towards acute water scarcity, such as Bengaluru, Pune, Hyderabad, Chennai, Coimbatore, Kochi etc. Bengaluru is on the verge of an imminent water crisis as the city's water table is shrinking and recharge of groundwater is minimal due to unplanned urbanisation (Times of India, 2018). Similarly, many cities are affected with water pollution too, as polluting river flows along the cities, such as the river Mithi in Mumbai (Chatterjee, 2017).

Stakeholder perception

All types of stakeholders are involved in solving water pollution and water scarcity problems in India. NGOs are actively carrying out studies on water pollution and its effect (for example the Watchdog foundation (Chatterjee, 2017)) as well as on water harvesting and water management systems. Research organisations or knowledge centres, such as the Centre for Science and Environment (CSE), also carry out studies on sustainable water management (CSE, 2014). Media, such as The Times of India and Hindustan Times, are covering issues on water problems, raising situational awareness among the inhabitants and informing about actions that can be taken.

6.4 Noise pollution

Brief description on drivers and causes

Community noise, noise emitted from automobiles, construction work, recreational activities, fireworks, etc., are high in metropolitan cities in India. The increasing population, transportation demands, increase in vehicles and road congestion have increased traffic noise pollution, including vehicular horns (Community Noise Pollution in Urban India: Need for Public Health Action, 2014). Motor vehicles are the main sources of urban noise emission which contributes about 55% to the total noise (Evaluation and Analysis of Environmental Noise Pollution in Seven Major Cities of India, 2017). Due to the rapid urbanisation process in India, there is often a lack

of proper urban planning – for example in the form of an unmatched layout of roads, highways and buildings, or when industrial, residential, and commercial areas lie in close proximity to each other, disturbing the quiet environment of residential areas (Community Noise Pollution in Urban India: Need for Public Health Action, 2014). Many Indian cities are above the threshold noise levels, which could otherwise cause health problems.

Impacts

Noise pollution has become a major problem in India, mainly in urban areas. According to data from India's Central Pollution Control Board (CPBC) and independent reports, traffic sound averages amount to 100 decibel (db) at Indian urban streets, which is similar to the sound of a leaf blower from about a meter away (Study on Unneccessary Honking During Red Traffic Signals in Urban Area With Special Reference to Kolhapur City, 2017). The people exposed to high noise areas are at risk of serious health risks including hearing loss or impairment, increasing stress levels, behavioural and mental problems etc. (indiaonline, n.d.).

Affected cities

According to India's Central Pollution Control Board (CPCB) analysis (2011-2014), noise pollution is high in Indian cities. The worst is in Mumbai (livemint, 2016), followed by Lucknow, Hyderabad, Delhi and Chennai (The Times of India, 2016). The noise level in Mumbai reaches up to 110 db. Since 2016 this level is reportedly improving in Mumbai due to bans on honking and due to governmental measures, such as fines. In 2017, the regional transport offices of the Maharashtra Motor Vehicle Department (MMVD) had begun a campaign to raise awareness on the dangers of noise pollution (Magagula, n.d.).

Stakeholder perception

Researchers in India have been actively involved in the assessment and impact of noise pollution (Assessment of Noise Pollution Indices in the City of Kolhapur, India, 2012). Policy makers and pollution control authorities in India, both the national and state authorities (e.g. the Central Pollution Control Board (CPCB) and the Maharashtra Pollution Control Board) are conducting studies on noise levels, in which NGOs, such as Awaaz Foundation, are also involved. However, noise pollution has been less focused by donor agencies until now.

6.5 Land sealing and loss of green and open spaces

Brief description on drivers and causes

Rapid urbanisation, unplanned growth and widespread urban sprawl resulted in green cover depletion and reduced open space due to an increased demand of infrastructure and building construction in many Indian cities, causing land sealing and environmental degradation. The UN (and WHO) recommended 9 m^2 of green space per capita as a standard. However, cities in India such as Chennai and Mumbai have 0.46 m^2 and 0.12 m^2 of green space per capita respectively (Urbanisation and greening of Indian cities: Problems, practices, and policies, 2016). Moreover, the WHO recommend open space of at least 15% of a city's total area. Most Indian metros fall below the standard. Mumbai's public open space is only 2.5% of the city's total area and Kolkata is even worse. In many Indian cities, there is less and less green and open space, and built structures (buildings and road infrastructure) are booming, turning cities into 'concrete jungles' and sealing land (Mitra, 2013). Therefore, urban air quality has deteriorated and urban heat islands (UHI) are emerging (Urbanisation and greening of Indian cities: Problems, practices, and policies, 2016). Sealing permeable land also affect ground water causing water shortage and surface flooding.

Impacts

Land sealing, the lack of green space and the unshaded structure cause a threat to local climate in Indian cities due to intensified UHIs effect. In some Indian cities, such as Bangalore (Bengaluru), urban pockets were found to be about 2°C warmer than rural area, increasing the temperature in summer (TERI, 2017). Several health hazards are recorded due to thermal discomfort in heat islands such as heat strokes, heat exhaustion, infectious diseases, and cardiovascular and respiratory problems that aggravate during summer seasons among citizens (Urbanisation and greening of Indian cities: Problems, practices, and policies, 2016). Increased heat transfer indoors has led to increased electricity consumption for cooling in many buildings in Indian cities (TERI, 2017). Beside the effect of UHIs, cities also experience urban flooding during heavy rains, such as in Bangalore and Mumbai (Hindustan Times, 2017). In peri-urban areas in Indian cities, land encroachment for infrastructure takes place which has the potential for irrigation, degrading the soil.

Affected cities

Cities like Pune, Visakhapatnam and Chennai have reduced green space, namely 1.4, 0.18 and 0.46 m^2 green space/inhabitant respectively (Urbanisation and greening of Indian cities: Problems, practices, and policies, 2016). The open space is vanishing in Kolkata, too, and the city needs to have 50% more open space to meet the UN standard of minimum open space (Mitra, 2013). The loss of green and open space has contributed to the growth of urban heat islands and increased urban flooding. Mumbai, Chandigarh, Bengaluru and Agartala are among the worst affected by urban flooding (Vachana, 2017).

Stakeholder perception

National and international media are active in reviewing land sealing and its consequences in Indian cities. Researchers have been carrying out studies on the reasons for land sealing as well as the minimization of its effect in India since decades. Policy makers are formulating various initiatives (at different sectors) to curb the source and the effect of land sealing under the plans related to climate change.

6.6 Waste generation and management

Brief description on drivers and causes

With rapid urbanisation, growing economic activities and changing lifestyles, India is facing a huge waste management challenge for both municipal and industrial waste, mainly in urban local bodies. Indian per capita waste generation adds up to 300–400 gm/capita for medium cities and between 400–600 gm/capita for large cities. However, the amount of waste is likely to increase with the present trend of urbanisation and consumption patterns. According to the Central Pollution Control Board (CPCB) (2012–13), municipal areas in the country generate around 170,000 metric tons of municipal solid waste (annual generation of 62 mn tons of waste) per day (ASSOCHAM, 2017). The typical rate of increase in waste generation in Indian cities is estimated at around 1.3% yearly (Pamnani, et al., 2014). The volume of waste in Indian cities is expected to increase by 5% per year due to the increase in population and changing lifestyles (Planning Commision, 2014). Along with the increasing waste generation, challenges also include inadequate waste collection, transport, treatment and disposal. The informal sector or waste pickers extract value from waste, with approximately 90% of residual waste currently dumped rather than properly landfilled (Kumar, et al., 2017).

Impacts

Poor management of waste in many Indian cities has direct implications to air, water, and soil pollution, and long-term health impacts and hence indirect implications to economy and growth

prospects (ASSOCHAM, 2017). Due to the release of methane from open waste dumps, the danger of fires and explosions is high. There are also problems of odour and migration of leachates to receiving waters. Municipal wastes are burnt (both at landfill sites and in open air), polluting air which cause respiratory diseases and smog. For example, open burning of municipal waste emits 22,000 tons of pollutants into the atmosphere around Mumbai every year. In general, the poor waste management has a huge impact on public health in India (Kumar, et al., 2017), mainly for informal waste pickers. Besides that, a significant amount of improperly disposed plastic wastes end up in the ocean, affecting marine animals and polluting beaches (e.g. Mumbai beach).

Affected cities

Most of India's urban areas with high population density, mainly large metropoles such as Mumbai and Delhi, are affected by a huge amount of waste generation and inadequate management (Kumar, et al., 2017).

Stakeholder perception

Waste management is discussed among policy makers and it is getting stringent over time. Various studies have been carried out by the Central Pollution Control Board as well as at the state level (e.g. Delhi Pollution Control Committee). Researchers are carrying out research on waste management in a national perspective and on a local level (Pamnani, et al., 2014). The media is also active in India to raise awareness in waste management issues.

6.7 Summary

The following table summarises the conclusions, employing the five categories to evaluate environmental challenges at the urban level as developed in the methodology section. From a country's point of view, it appears that air pollution, water pollution, climate change and waste generation/management are the most pressing challenges of urban environmental protection.

Table 7: Summary of extent of environmental challenges at the urban level in India

Environmental challenge	Main drivers	Significance of challenge
Air pollution	Fuel wood and biomass burning, crop fires, Garbage combustion, road dust, vehicles, industry and power plant sources	Very high: all stakeholders discuss it, all urbanised areas are affected, vehicles are the most consistent and dominant source of pollution throughout the year
Climate change and its effects	Urbanisation, energy sector, agriculture, industrial processes, land-use change and forestry and waste	Very high: all stakeholders discuss it, all urbanised areas are affected, diverse effects of climate change
Water pollution and availability	Urbanisation, ground water extraction, untreated urban water (sewage, industrial waste)	Very high: all stakeholders discuss it, many large cities are affected. Most of the water planning and development in India is done as per administrative boundaries rather than by using river basins as the hydrological unit
Noise pollution	Transport	Medium: Experts and national media discuss it. On a national level, a strict enforcement of laws for noise control is necessary. Awareness of the

Environmental challenge	Main drivers	Significance of challenge
		public and stakeholders is required in the prevention and control of community noise pollution
Land sealing and loss of green and open spaces	Green cover depletion and reduced open space due to increased demand of infrastructure and building construction	high: National and international media and experts discuss it as a problem mainly in the large cities. Rapid urbanisation, unplanned growth and widespread urban sprawl caused land sealing
Waste generation and management	Municipal waste and industrial waste	Very high: All stakeholders discuss waste management issues, all urbanised areas are affected. The volume of waste in Indian cities is expected to increase by 5% per year with increase in population and changing lifestyles.

Source: Own compilation, Wuppertal Institute

7 Urban environmental challenges in China

This section describes challenges of urban environmental protection in China, following a similar structure as in the previous chapters.

7.1 Air pollution

Brief description

Air pollution has long been recognized as a serious issue in Chinese cities, which has drawn attention from a wide range of stakeholders in China and international organisations. The Chinese government introduced nation-wide measures, being able to decrease air pollution significantly. In case of ineffectiveness or temporary pollution events, the government can introduce emergency measures.

Impacts

Air pollution has long been recognized as a serious problem in China. However, the recent severe smog and its associated health and economic impacts have made it a salient issue in China. In the winter of 2012, some regions experienced smog episodes with real-time PM2.5 levels exceeding 1,000 µg/m3 (an average annual concentration of 10 µg/m3 PM2.5 is regarded to be unsafe by WHO). Exposure to PM2.5 can cause adverse health effects including cardiovascular and respiratory morbidity and mortality and outdoor exposure contributed to over one million deaths in China in 2013 (Yixuan et al. 2017). Research indicates that economic costs associated with air pollution in China is between USD 100 and USD 300 billion a year (UNEP 2015).

Affected cities

Air pollution is a major concern in Chinese cities. Since 2013, Chinese government has „declared" war against air pollution. Air quality has been improved in the last years, especially, in the severely polluted metropolitan regions such as Beijing-Tianjin-Hebei region. However, according to Greenpeace, the PM 2.5 level of 256 of the 365 sample cities exceeded 35 µg/m3 (WHO's latest "interim" target) (Greenpeace 2018).

A Greenpeace study concludes that, in the most affected region, Beijing-Tianjin-Hebei area, air pollution has been mainly caused by coal-based power generation, industrial production of steel, cement and brick, and road transport (Guan & Liu). Chinese government has embarked on a wide range of strategies and measures, which has resulted in significant improvement of air quality. However, major short-term pollution events have still happened, which triggered the toughest emergency measures such as banning polluting vehicles and closing energy intensive industry (Zhang 2017).

Stakeholder perception

All stakeholder groups perceive or frame air pollution as a major issue for Chinese cities including national and international media (Zhang 2017), NGOs/civil society groups (Greenpeace 2018), researchers (Yixuan et al. 2017; Guan & Liu n.a.), and policy makers/authorities (see policies below).

7.2 Climate change and its effects

Brief description on drivers and causes

The rapid urbanisation in China has resulted in significant increase of GHG emissions. At the same time, many cities will be suffered from rising sea level and increasing droughts and floods.

Chinese government made strong commitment to climate mitigation. It has developed national strategies on both mitigation and adaptation and rolled out a series of pilots.

Impacts

China has overtaken the United States as the world's largest emitter of CO2 since 2007. During the period of 2002-2007, in average, China's CO2 emissions increase by 13% annually (Shan et al. 2017). In the recent years, China has taken positive steps to reduce its emissions. Since 2011, its emissions growth rate has dropped significantly. In 2015, its emissions even went down by 0.7%, which was mainly attributed to decrease in coal consumption and increase in non-fossil fuel in primary energy consumption. Still, China is now responsible for about one third of global CO2 emissions (Global Carbon Budget 2017). Among others, its energy production and heavy industrial processes have been the primary contributors to CO2 emissions.

Affected cities

China's fast-growing coastal megacities with 145 million people could be threatened by rising ocean level as a result of climate change (Strauss, Kulp & Levermann 2015).

Besides, climate change has resulted in an increase of extreme events. A recent study shows how much of urban infrastructure in China is vulnerable to natural hazards. In the study, 66 cities are found to be exceptionally exposed to flooding, which affects sub-sectors including rail, aviation, shipping, electricity, and wastewater. 99 cities are vulnerable to increasing droughts that may cause suspension of energy production (Hu et al. 2016).

Stakeholder perception

Many stakeholder groups perceive or frame climate change and its effects as a challenge for Chinese cities including national and international media (Henderson et al. 2016), NGOs/civil society groups (various Greenpeace initiatives) researchers (Shan et al. 2017; Strauss, Kulp & Levermann 2015; Song et al. 2015; Hu et al. 2016), policy makers/authorities (Central People's Government of the P.R.C 2017).

7.3 Water pollution and availability

Brief description

Water pollution is a major concern in Chinese cities. On top of that, those in northern China have also long suffered from water scarcity. In the last years, the Chinese government issued stringent policies to control both water quality and water quantity. There has been an increasing attention among public on water quality. The monitoring and supervision of water quality at local level has becomes more and more strict.

Impacts

China's total annual renewable volume of water amounts to 2812 km^3, which is the sixth largest volume in the world (Xie, 2009). Globally, China also has the greatest total length of rivers. Despite this abundant total water resource, the, annual freshwater resource per capita in China was only about a quarter of the world average, i.e. less than 2,000 m^3 (MWR, 2012; Liu and Yang, 2012). There is also a strong geographical split between water availability in southern and northern China: natural water resources are much scarcer and water stress is much higher in northern China than in southern China. Northern China has 60% of the farmland and 40% of population, but only 20% of natural water resources (ADB 2017). Besides, extensive use of groundwater has caused groundwater resource depletion. The most developed Chinese cities rely on groundwater, which is being overexploited by 22 billion m^3 annually (Bateman 2014). Water scarcity in China has further been aggravated by a deterioration of the water quality. 73%

of the watersheds that supply water to 30 fast-growing cities face medium to high pollution levels (The Nature Conservancy 2016).

Affected cities

Northern Chinese cities have long suffered from water scarcity combined with water pollution. For example, in Tianjin, a key port city under water shortage in northern China, according to its environmental report, 50% of its water so polluted that it was essentially functionless in 2016 (Tianjin Environmental Protection Bureau 2017).

Stakeholder perception

All stakeholder groups perceive or frame water pollution and availability as a challenge for Chinese cities including national and international media (various news in Xinhua News, Reuters 2015), NGOs/civil society groups (The Nature Conservancy 2016), researchers (Bateman 2014; Cosier & Shen 2009), policy makers/authorities (Tianjin Environmental Protection Bureau 2017, Central People's Government of the P.R.C. 2012) and others (ADB 2017).

7.4 Loss of biodiversity

Brief description

The construction of urbanisation infrastructure and associated land use change as well as water pollution resulted from urbanisation constitute serious threats to biodiversity. The Chinese government has promoted biodiversity conservation in cities through its program of eco-cities and garden cities.

Impacts

China has a vast territory with various and complicated types of ecosystems that foster rich plant and animal resources. China ranks as 3rd in the world due to its high number of plant species and as 12th with regard to its biodiversity richness, accounting for 13,7% of the world's total number of vertebrate species. Besides, China is the origin and distribution of important crops such as rice and soybeans, and of wild and cultivated fruit trees. Nonetheless, China is also one of the countries facing serious threats to biodiversity (MEP 2014), especially, considering its rapid urbanisation (Xie & Ng, 2013, McDonald et al. 2013).

Urbanisation, for example, the construction of urbanisation infrastructure and associated land use change can cause fragmentation, dispersal and even complete destruction of natural habitats and their native species (Güneralp 2015). Another significant impact is loss of urban green space. Large areas of urban green spaces have been turned into impervious surface. Such an expansion of build-up area has resulted in simplification of green space, which might deprive the habitats for creatures, disrupt the structure of habitats and ecological processes, and reduce biodiversity (Kalisch et al. 2017).

Affected cities

Most cities have been facing similar above-mentioned challenges, including the reduction of urban green space, converting green zones into residential or commercial areas or building new infrastructure. Due to rapid urbanisation rates in the country, the problem of biodiversity loss affects Chinese cities in a similar way.

Stakeholder perception

Mostly, researchers perceive or frame the loss of biodiversity as a challenge in China (Xie & Ng, 2013; McDonald et al. 2013). The Chinese government has also formulated policies to conserve biodiversity. Most importantly, the Chinese government has introduced the National

Biodiversity Strategy and Action Plan 2011-2030 (NBSAB), specifying national targets, and incorporated biodiversity as a key element in the national standard for garden cities. Besides, international natural conservation NGOs such as WWF draws their attention on biodiversity issues.

7.5 Soil pollution

Brief description

Soil pollution in urban area has increasingly drawn attention from both government and public. Reconstruction of brownfield sites of former industry plants is a major reason. In response, the central government set a national plan with clear targets. However, there is still a huge financing gap.

Impacts

According to a report released by the central government in 2014, 16.1% of the Chinese soil was polluted (MEP and MLR of P.R.C, 2014). The major drivers of soil contamination include industrial plant waste and mining operations as well as unsustainable use of chemical fertilizers and pesticides in agriculture practice (Chen et al. 2014).

Affected cities

There are more than 5000 brownfield sites of former industry plants in major cities, of which about 35% exceeds national pollution standards, sometimes, by hundreds of times the official limits (Hong et al 2014, Hu 2016, Yao 2016). To meet the demand of rapid urbanisation, thousands of brownfields have become sites for the construction of residential buildings, schools and shopping centres. Currently, the treatment of contaminated sites is only superficial. Mostly, residents of newly built houses are not informed about the feature of the land (Yang et al. 2012). Serious acute poisoning incidents of construction workers were already registered during construction on sites of former pesticide factories in Beijing and Wuhan (Gao & Wang, 2012).

Stakeholder perception

All stakeholder groups perceive or frame the soil pollution as a challenge for Chinese cities including national and international media (various in Xinhua News; The Economist 2017), NGOs/civil society groups (Greenpeace 2014), researchers (Hu 2016, Yao 2016, Yang et al. 2012), and policy makers/authorities (MEP and MLR of P.R.C 2014, policies below).

7.6 Waste generation and management

Brief description

Rapid urbanisation in China has resulted in large amount of municipal solid wastes (MSW) and building wastes. While they are sources of pollution, they contain valuable resources that can be recycled. The central government issued national actions to increase the MSW treatment capacity as well as recycling and utilisation of MSW.

Impacts

Rapid urbanisation and socio-economic development in China has resulted in large amount of municipal solid wastes (MSW) and building wastes. In 2015, Chinese cities generated more than 190 million tons of MSW (Li et al. 2016). MSW is largely disposed of in landfills. In 2016, 657 landfill facilities had total daily waste treatment capacity of 350103 ton and shared 56% of treatment capacities in China. 249 Incineration plants were in operation, which accounted for 41% of the treatment capacity (MOHURD 2017). Despite the large number of facilities, there is

still a significant gap between the treatment capacity and MSW produced. For example, in Beijing, the daily gap was 18000 ton per day in 2015 (People 2014). On the hand, the heavy reliance on landfill leads to environmental problems. The impropriate decomposition leads to emissions, methane, which poses significant impacts on climate change. Besides, landfill is considered as an important source of groundwater contamination due to the leakage of leachate. Incineration provides an alternative to landfill. However, due to, for instance, impropriate operation and MSW separation as well as poor regulation, incineration plants emit toxic waste gas, which have significant impacts on environment and public health (FoN 2015). While MSW is a source of pollution, it also contains valuable resources that can be recycled. Currently, the development of utilization of MSW is still at its infant stage. Until 2015, the utilisation rate was below 5%.

In 2013, building wastes amounted to one billion tons in China, which included 70% of demolition wastes and 30% of new construction wastes. The untreated building wastes occupy large areas of the lands, potentially contaminate both surface and ground water, and lead to air and soil pollution (EF n.a.). The utilization of building wastes was only 50 million tons and the utilisation rate was only 5% (NDRC 2015a).

Affected cities

Most highly populated cities in China generate a large amount of MSW and face a significant gap between the treatment capacity and generated MSW. Inproper treatment of the MSW has resulted in a series of environmental problems, such as surface and ground water, air, and soil pollution.

Stakeholder perception

All stakeholder groups perceive or frame waste generation as a challenge for Chinese cities including national and international media (People 2014), NGOs/civil society groups (FoN 2015), researchers (Hu 2016, Yao 2016, Yang et al. 2012), policy makers/authorities (the policies below) and others (EF n.a.).

7.7 Summary

Based on the above analysis, the following conclusions can be drawn:

- The most prominent themes of urban environmental protection that gain attention from a broad scope of stakeholders are air pollution, climate change, water pollution and waste generation and management. The issue of soil pollution is also important. While there is national plan of biodiversity conservation, it is of less significant in the context of urban environmental protection.
- Urban activities contribute to most environmental impacts analysed above, such as continuously growing energy demand of different sectors, motorised transport, and industry.

The following table summarises the main drivers and significance of environmental challenges at the urban level.

Table 8: Summary of extent of environmental challenges at the urban level in China

Environmental challenge	Main drivers	Significance of challenge
Air pollution	Coal-based power generation,	Very high: gaining attention from all stake-

Environmental challenge	Main drivers	Significance of challenge
	industrial production of steel, cement and brick, and road transport	holders and staying high on political agenda; affected all cities; largely exceeding the threshold.
Climate change and its effects	Energy supply, transport, industry, buildings	Very high: gaining attention from all stake-holders and staying high on political agenda; cities are hotspots of climate change and will be suffered from the impacts, especially, coastal cities. China is the largest emitter in the world.
Water pollution and availability	Natural condition, industry, agriculture, and climate change	Very high: gaining attention from all stake-holders and staying high on political agenda. Being major concern of Chinese cities, in terms of water quality and water availability.
Loss of biodiversity	Water pollution, Land use and transformation	High: drawing attention from academics and NGOs focused on natural conservative, but also from the Chinese government
Soil pollution	Urban expansion, land use	High: gaining attention from all stakeholders but significantly lack of funding. There are more than 5000 brownfield sites of former industry plants in major cities, of which about 35% exceeds national pollution standards.
Waste generation management	Urbanisation, Lack of waste treatment capacities, heavy reliance on landfill, low utilisation	Very high: gaining attention from all stakeholders and staying high on political agenda. Most cities are affected.

Source: Own compilation, Wuppertal Institute

8 Urban environmental challenges in South Africa

This section describes challenges of urban environmental protection in South Africa, following a similar structure as in the previous chapters.

8.1 Air pollution and acid rain

Brief description

Indoor and outdoor air pollution in South Africa is a serious problem; with emissions for sulphur dioxide, particulate matter, nitrogen dioxide, nitrogen oxides, ozone, benzene and Volatile Organic Compounds (VOC)s, and the corresponding concentrations becoming major concerns. South Africa's air quality is affected by various sources, which include power generation activities based on coal, industrial processes, waste disposal, transportation (private and public), biomass burning, domestic fuel burning, landfill sites, waste water treatment and agriculture (SA Department of Environmental Affairs, 2016).

Impacts

Air pollution leads not only to serious health challenges, but also to economic productivity losses and a higher mortality rate. In 2012, 7.4 per cent of deaths resulted due to chronic exposures to air pollution (in particular to particulate matters), which also contributed to a decrease in South Africa´s GDP by 6% (Altieri & Keen 2016). A study undertaken by the World Bank (2016), further concluded that the South Africa air pollution causes economic losses of nearly ZAR 300 million each year and is the direct result of 20 000 deaths. This is evident in the Mpumalanga province; for instance, which is also one of the world´s heaviest polluted areas. Life expectancy for males is around 50 years, for women around 52 years. Moreover, children living in pollution priority areas have an increased risk of wheezing due to exposure to indoor and outdoor air pollution, with an estimated 42% of households having one case of sinusitis and 10% of having someone with asthma. Air pollution from multiple sources in South Africa contributes to the high burden of respiratory ill-health issues, with respiratory ill-health being one of the top five killers of children under the age of 5-years old. The poorest and most vulnerable are more likely to be adversely effected by worsening air pollution conditions and climate change resulting, in most instances, in death and diseases (Wright, 2017). The World Bank estimated that 20 000 South Africans are killed by air pollution each year and the economy loses around ZAR 300 million yearly (South Africa today, 2017). The Highveld Priority Area has impacted the surrounding community negatively by contributing to more than 2, 200 deaths per year and by causing thousands of cases of health related illnesses such as bronchitis, asthma. This negatively affects the SA economy by more than ZAR 30 billion annually because of premature deaths, hospital admissions and loss of working days (Sangonet Pulse, 2018). A large number of children is affected by indoor and outdoor air pollution resulting in increased risk of wheezing. Exposure to smoke near schools where higher and many low-income homes are situated near road infrastructure that caters for a large volume of trucks which usually are part of an aging vehicle fleet that emit toxic engine exhaust fumes. The South African Medical Research council (SAMRC) evaluated that 42% of all households in SA had one case of sinusitis, and 10% had someone with asthma due to air pollution related causes. The overall prevalence of respiratory ill-health symptoms was 34.1% - with a significantly elevated portion found among children from households using non-electric fuels (Wright, 2017).

Affected Cities

In particular cities that are located in the proximity of industrialised areas are affected by challenges of air pollution, leading to "hot spots". An example is Secunda, located close to the

coalfields of the Mpumalanga province, generating the largest amount of CO2 emissions worldwide. Cities with a high population density such as Cape Town, Durban, Johannesburg-Pretoria are characterised by the highest mortality due to air pollution (Altieri & Keen 2016). The most air-polluted cities in South Africa in 2016, where Hartebeespoort, Tshwane, and Johannesburg. Hartebeespoort, situated between Johannesburg and Tshwane, has many mining operations/mines that contribute to high levels of pollutants in the air. The nearby Pelindaba nuclear plant is also a factor to Hartebeespoort being the number one area in South Africa for air pollution, due to the constant release of sewage and nuclear waste from the plant being emitted. The city of Tshwane is affected by high number of vehicle emissions from high ways, brickwork construction, and the large number of coal and wood energy sources. Johannesburg has a large density of population, being South Africa's financial capital, and the city's environment has a serious impact on the air and has increased respiratory issues such as lung cancer and early deaths amongst its residents (South Africa today, 2017).

Stakeholder Perception

With increases in population density in most urban areas in South Africa, increased stresses on existing infrastructure and inadequate public services such as an efficient public transport system, non-governmental organisations, media, and international organisations have expressed disappointment in the response to air pollution and its rising incidence rate of associated health issues. Non-profit organisations have expressed concerns that SA's air pollution exceeds ambient air quality standards and are weaker than the out-dated World Health Organisations guidelines. The national ministry of Environment and Health are aware of the state of the air pollution yet the response has not been urgent or forthcoming. State-owned energy producers have also been implicit in delaying government's response by periodically applying for postponements to the implementation on sulphur dioxide emission regulations. Research institutions and knowledge producers, such as the University of Cape Town's Energy Research Centre, Highveld Environmental Justice Network, groundwork and the Centre for Environmental Rights have published reports and articles calling for policy and mechanisms to address the increasing rate of air pollution and its relation harmful consequences – particularly the legal implication of not implementing internationally recognised regulations and standards. In 2015, civil society and community organisation vehemently opposed the postponements of the deadline for the state-owned power generator, Eskom, to issue its minimum emissions standards (EMS) that regulate the maximum amount of air pollution released by industry. The organisation involved in the protest action include the Highveld Environmental Justice Network (HEJN), Life after Coal campaign, Earthlife Africa – Johannesburg, GroundWork, and the Centre for Environmental Rights (Sangonet Pulse, 2018).

8.2 Climate change and its effects

Brief description

South Africa accounts for 1.6 per cent of global emissions and ranks number 12 of the largest GHG emitters of the world and accounting for 65% of total emissions of the African continent, (South Africa Habitat National Team n.d.). With 80 per cent of total emissions, the energy sector holds the largest share of CO2 emissions due to South Africa´s reliance on fossil fuels, including power and heat (295 MtCO2), manufacturing (55 MtCO2) and transportation (52 MtCO2) (EDF & IETA 2014). South Africa´s GHG emissions put the climate system and its population at risk of socio-economic and ecological consequences.

Impacts

South Africa´s GHG emissions set the climate system and the population of South Africa through socio-economic and ecological consequences at risk. In particular South Africa´s agricultural sector is affected due to the increase in temperature and increasing irregularities in rainfall. Moreover, the rise in sea level affects not only the South African urban and rural settlements that are located close to the sea but also South Africa´s ecology and wildlife cycle (South Africa: Social Perspective of Environmental Issues n.d.). South African business have been surveyed to not be evaluating the impacts of climate change and adequately adopting measures to counter-act negative consequences. As such, value chains are not being analysed and key stakeholders not taking the crisis serious enough. In 2018, the South African National Business Initiative published a report which indicated that one of the key-barriers to implementing adaption measure is a lack of buy-in by senior management as climate change is viewed more as an environmental risk rather than a risk to the survival and longevity of the business itself (Climate change is definitely affecting SA Businesses , 2017). South Africa is one of the most vulnerable countries in the world that also has a high incidence of life-threatening diseases, high levels of poverty and unequal access to health. Climate change presents the possible expansion of malaria zones, spread of dengue virus, distribution and quantity of pollen and other allergens and also worsen respiratory conditions such as asthma and allergic rhinitis (Climate Change and its affect on healthcare systems, 2018). Therefore, human safety and in 2016, Hartebeespoort was ranked the most polluted city in South Africa with more than 60mg/m3 of 2.5 PM according to the World Health Organisation (WHO 2016). The Climate Central research advocacy group predicts that one million South Africans live in areas that will be inundated by rising seas levels as climate warms and unless carbon emissions are reduced dramatically by year 2100 (Rising seas from warming climate threaten major cities in Africa, 2018).

Stakeholder Perception

Considering the central protection of the environment within South Africa's constitution, GHG emissions and its impact on the climate is perceived as a threat to public health. National and international media (Enca 2016), researchers (Altieri & Keen 2016), NGOs /civil society (Naca n.d.) and policy makers/authorities are concerned by the impact of climate change and the topic holds significant importance in the national and regional discourse (Centre for Environmental Rights in South Africa n.d., South Africa Habitat National Team n.d.). Although public and private sector stakeholders display keen awareness of climate change issues, national and regional policies, mitigation and adaptation strategies have not been identified or rollout with adequate urgency.

8.3 Water pollution and availability

Brief description

Water is a scarce resource in South Africa. As a semiarid country, South Africa experiences a limited amount of rainfall. As a consequence, underground aquifers are rare and water needs to be imported from neighbouring countries. The draft National Water and Sanitation Master Plan of South Africa published in 2018, indicates that the demand for water will outstrip the supply in approximately 12 years' time. This factor is mostly related to population growth, rise in household and industrial consumption patterns, poor physical and commercial usage and the impact on the ecosystem by climate change (Water Resource Group 2018). In addition, South Africa´s agricultural sector uses 60 per cent of the total water supply and due to poor infrastructure (such as leaking water pipes, inaccurate canal conveyance systems) 35 per cent of this water is lost. The Water Resource Group (2018) further predicts that in 2030 "under the current efficiency levels, there will be a supply-demand gap of 17 per cent" in South Africa. A

trade-off between South Africa´s agriculture, its industry and a steadily increasing urban growth has to be resolved (Boccaletti et al. 2010).

Besides water scarcity, South Africa also faces the challenge of water pollution, which is mostly provoked by anthropogenic factor such as chemical waste disposal, waste of metals through industry mining as well as pesticides and other toxic substances that are introduced to water resources through agricultural and economic activities (SACN 2016).

Many rural communities or areas previously administered by apartheid discriminatory laws are plagued by drying boreholes, broken and poorly managed infrastructure, and lack of or degraded infrastructural services. Within urban areas the pressures of urbanisation and demand on local government authorities are not materialising the values of the National Water Act or the precepts of the democratic constitution. Moreover, more than two-thirds of the wastewater treatment facilities in South Africa do not meet the minimum quality control standards. The Water Research Commission in its "Green Drop Report, 2014" found that 25% of South Africa's wastewater treatment facilities are in a critical state, while another 25% are defined as high risk in terms of disrepair (Makhafola, 2018).

Impacts

Within South Africa, water scarcity and water pollution do not only impact the environment, but also the population in South Africa. Access to water has become a sensitive issue in South Africa, not only due to its impact on the environment and on the population with regards to health, but also politically. "Linked to class struggles and social status (…) it is an issue which is used by politicians as a benchmark of their successes or of their opponent´s failures" (Pereira n.d.). Moreover, water restrictions were introduced, affecting households in particular within cities. For instance, the Cape Town municipality turns off the tabs as soon as dam storage reaches 13.5 per cent (City of Cape Town n.d.). On a larger scale, in particular with regards to South Africa´s challenge concerning water scarcity, Lesotho, possessing Africa´s second largest dam, is affected, since it exports water to South Africa. Droughts and volatile rainfalls lead to damaged harvest of crops and the need for food and water assistance (England 2016). South Africa's economy is also heavily dependent on a steadily and high consumption of water resources – without adequate planning and management of the water resources social faces the burden of increases in socio-economic inequality. The impacts of climate change can be shown in South Africa experiencing three consective years of below-average rainfall around Cape Town causing the reservoir levels in the city to drop to dangerously low levels in late 2017. This resulted in the city administration rationing water – indicated future drier conditions that could become the norm across the southern African region.

Affected Cities

Most urban centres in South Africa have an inter-basin water transfer and over the last 20 years access to potable water has been made available to over 90% of its households (some rural areas such as Buffalo and eThekwini remain without services). Insufficient wastewater control and inadequate downstream water management still affect some communities, and have lead to negative effects on water quality and consequently on human health. While almost all larger cities have managed to deliver adequately treated water to households, wastewater remains a challenge across all urban centres (SACN 2016). In late 2017 and going into 2018, the City of Cape Town faced severe water shortages. The complex issue of the City of Cape Town reveals the dire consequences of inadequate political will to existing research, reality of climate change and the impact to all sectors of society when a pending crisis is not managed well. In 2021, the UN World Water Development Report 4 identified South Africa as being a region in the world that will be physical water scare (Cape Town Crisis: How does a global city run out of water? , 2018).

The water infrastructure in South Africa have are vestiges of apartheid and government investment have not focused on fixing damaged infrastructure or upgrading the system. An estimated 50% of wastewater is treated nationally revealing an existing possibility to increase water supply.

Stakeholder Perception

Water scarcity as well as water pollution are perceived as a threat to public health and to the environment by national and international media (England 2016), researchers (Cilliers & Siebert 2012), international organizations (Water Resource Group 2018), NGOs /civil society (Pereira n.d.) and policy makers/authorities. Due to the City of Cape Town's extreme water shortage problems in 2017, South Africa continues to receive a lot of attention regarding its management and usage and scarcity issues related to water. The South African Institute of Security Studies (2018), is of the understanding that South Africa needs to have a coordinated approach to waste water management across all tiers of government – national, provincial and local. Currently, South African are overexploiting its water resources which is impacting the water system to efficiently dilute those particulates and regenerate itself (Makhafola, 2018)

8.4 Desertification and land degradation

Brief description

91 percent of South Africa´s surface is classified as semiarid area and is susceptible to desertification. Triggered through its geographical conditions, but also through anthropogenic factors such as agricultural and industrial urban activities, urban development, deforestation and alien plant invasion South Africa faces high risk of land degradation and desertification. According to a report of the United Nations, 30% of South Africa´s surface were already affected by the phenomenon of desertification in 2007 (ECOSOC 2007). As a direct consequence of South Africa´s previous apartheid governance's system a lack of an adequate system of land ownership, land tenure laws and unjust distribution of agricultural land exacerbated the phenomena of desertification in the country (Department of Environmental Affairs, South Africa 2012a).

Impacts

Desertification and land degradation deteriorate the integrity of water and land resources, affecting in turn not only the ecosystem of South Africa but also human welfare. With respect to the latter, financial aspects must be considered. For instance, dam sedimentation and water treatment cost on average two-billion rand per year (Department of Environmental Affairs n.d.). Moreover, a misuse of irrigation strategies in agriculture leads to a vicious cycle of water security challenges on a national scale. Another possible consequence of land degradation is the loss of productivity in agriculture and as a consequence - food scarcity (LCLUC n.d.).

Affected Cities

Urban settlements are not directly but rather indirectly affected by desertification and land degradation issues. These include aspects such as financial burden for the urban population (e.g. for water treatment) or migration patterns into cities triggered through the consequences of desertification for rural communities. In particular the latter may lead to overcrowding, unemployment and an increasing rate of poverty (LCLUC n.d.).

Stakeholder Perception

Desertification and land degradation are perceived as a threat to public welfare and to the environment by national and international media (Barbee 2015), researchers (e.g. Meadows &

Hoffman 2003; LCLUC n.d.), international organisations (ECOSOC 2007), NGOs /civil society and policy makers/authorities (Department of Environmental Affairs, South Africa 2012a).

8.5 Loss of Biodiversity

Brief description

South Africa ranks 3rd with regards to the world´s most biologically diverse countries (Brownlie et al. 2017). However, its biodiversity in particular within urban settlements is at risk due to challenges such as alien species invasion, over-exploitation of natural resources, mining areas, industrial and agricultural activities, increasing urbanisation rates, land sealing and noise pollution. In 2004, 34% of terrestrial ecosystems, 82% of river ecosystems and 65% of marine ecosystems in South Africa were threatened (Cadman et al. 2010).

Impacts

The impact on biodiversity due to the consequences of climate change is interlinked with social as well as economic aspects. On the one hand, wetlands and rivers are threatened due to an increase in temperature and due to a permanent increase in water demand which is expected to increase by approximately 50% until 2030. On the other hand, the loss of biodiversity destroys the basis for economic development in particular with regards to industrial activities such as commercial and subsistence fishing, horticultural and agricultural activities of indigenous types and the tourism industry (Cadman et al. 2010).

Affected Cities

Almost 50% of all mammal species in South Africa have their habitat in Western Cape province, which is also the province with the most visited national and international tourist, the City of Cape Town. According to some sources, Cape Town is the world´s most biodiverse city globally. However, due to a rapid increase in population rate (since 2011 Cape Town´s population increased by more than 30%) this biodiversity is at risk and various mammals are on the verge of extinction (De Jong 2017, Cape Town Green Map n.d.). National and local institutions are not adequately equipped or do not house sufficient trained staff to handle the impact.

Stakeholder Perception

The loss of biodiversity is perceived as a threat to public welfare and to the environment by national and international media (De Jong 2017), researchers (Brownlie et al. 2017), international organizations (Cadman et al. 2010), NGOs /civil society (GEF 2018) and policy makers/authorities.

8.6 Waste generation management

Brief description

According to a report of the World Bank, South Africa ranks with 54 425 tons of trash with regards to the amount of total waste disposal per day 15th worldwide (Infrastrucutrene.wes 2016). The lack of waste disposal or an efficient waste management system is just one reason for South Africa´s problem of waste generation. The large amounts of waste production of urban settlements, industrial waste production as well as illegal waste disposals lead to a large-scale environmental problem in the country (Mail & Guardian 2007).

Impacts

Rapid urbanisation leads to an excess waste generation in South African cities. As a consequence, the health of the urban population as well as the environmental sustainability of cities is at risk.

Affected Cities

Not much information is available about the degree of pollution waste produces in South African cities. However, there are a few examples that report the impact of waste production on the urban residents and in particular on the poorer part of the population. Johannesburg, for instance dumps its industrial and radioactive waste in close proximity to some townships affecting the local ecosystem as well as health of the residents (Balch, 2015) – and due to the apartheid governments spatial planning projects many existing waste dump sites are found near communities that most all times are impoverished and consist of the black-African population segment of society.

Stakeholder Perception

Waste generation and management and its environmental and socio-economic impacts are perceived as a threat to public health and to the environment by national and international media (Balch 2015, Infrastrucutrene.ws 2016), researchers (Nkosi et al. 2013), NGOs /civil society and policy makers/authorities (Department of Environmental Affairs South Africa 2012).

8.7 Summary

The most prominent themes in the context of urban environmental protection discussed in the country and about the country are air pollution and water availability. Desertification and biodiversity are important issues even in cities, as tourism is an important economic factor. Climate change mitigation appears to be regarded as a significant challenge, however mainly because of the two important economic sectors agriculture and tourism, but not for the cities. The following Table 9 summarises the conclusions.

Table 9: Summary of extent of environmental challenges at the urban level in South Africa

Environmental challenge	Main drivers	Significance of challenge
Air pollution and acid rain	Coal fired power generation for electricity use, rapid industrialisation, ageing vehicle fleets, road dust and cottage industries	Very high: all stakeholders discuss it, all urbanised areas are affected
Climate change and its effects	Electricity, fuel consumption, and heat generation	High: All stakeholders discuss it, but not wrt cities, urban and rural cities are affected
Water pollution and availability	Population growth, migration, increasing demand, agri-economic dependence, impact on the ecosystem by climate change	Very high: all stakeholders discuss it, all areas are affected, farming communities, large cities
Desertification and land degradation	Agriculture and industry, land tenure laws and unjust distribution of agricultural land	High: All stakeholders discuss it, but not wrt cities

Environmental challenge	Main drivers	Significance of challenge
Loss of biodiversity	agriculture and industry	High: All stakeholders discuss it, but not wrt cities
Waste generation and management	lack of official incineration and disposal sites, informal areas lacking basic infrastructure, recycle culture not integrated in society.	Very high: all stakeholders discuss it, all urbanised areas are affected,

Source: Own compilation, Wuppertal Institute

9 Urban environmental challenges in Indonesia

This section describes challenges of urban environmental protection in Indonesia, following a similar structure as in the previous chapters.

9.1 Air pollution

Brief description

The main drivers for air pollution are transport and mobility. Increasing individual motorisation rates in combination with inefficient engines, poor public transport systems and insufficient transport infrastructure cause emissions. Around 70% of city air pollution results from the transportation sector (CO, HC, NOx, SOx, PM, O3; Yudha 2017). Open waste dumps likely to be within city boundaries pollute the air, as well. Fossil-fuel-based cooking today constitutes a challenge rather to rural air pollution due the Government's Kerosene-to-LPG Conversion Programme (2007-2012), which predominantly addressed urban residents (World Bank 2013). Demand for housing does not only result in sealing of green and blue spaces (incl. urban tree logging; Indonesia Habitat National Team 2016), but increases the demand for energy from Indonesia's many coal power plants. Sulphur dioxide, carbon monoxide, nitric oxides and suspended particulates are increasingly emitted by power plants and smog production is rising, triggered by the increased use for energy use of buildings. (Kurniati & Nitivattananon 2016). Beyond urban boundaries intentionally and unintentionally fuelled forest fires in Indonesia or Malaysia affect urban air of north-ern cities (Pacific Media Centre 2016).

Impacts

Air pollution is considered to be a "public health hazard" (Vidal 2014a, Cochrane 2015). According to one source, "residents of Jakarta get only 27 days of clean air each year" (Conservation International 2017). One source (Vidal 2014a) also claims that air pollution in Southeast Asian cities affects economic life including tourism and food production. The source does not provide further information on the interlinkages of air pollution and its implications on economic life and food production in Indonesia. However, for Indonesia, Greenpeace (2017) assumes that "pollution could affect agricultural yields or increase input costs for farmers who will have to neutralize the soil." Ground level ozone arising from the interplay between volatile organic compounds (VOCs), nitrogen oxides (NO_x) and hot temperatures; both, VOCs and NO_x, in turn, result from gasoline-driven engines, e.g. installed in cars (U.S. EPA 2017). According to UNECE (n.d) ground level ozone is a problem worldwide affecting the structure and the development of plants. The overall global crop loss due to ozone is estimated to reach 6-16 percent for soy, 7-12 percent for wheat and 3-5 percent for maize (UNECE n.d.).

Affected cities

Urban air pollution can be regarded as a national problem across all or at least most urban areas mainly driven by transportation and congestion, specifically (Indonesia Habitat National Team 2016). Additional drivers such as forest fires affect certain areas predominantly. The literature on waste issues contributing to the urban emission stock focuses on Bekasi (Bantar Gebang) belonging to the Greater Jakarta area, even though waste management is a nation-wide challenge. The role of coal power plants as a driver for air pollution in cities is relatively unknown; one study by Greenpeace (2017) claims that „emissions from the existing and planned coal-fired power plants would increase SO_2 levels above the WHO guideline of 20µg/m³ in an area with an estimated 6.3 million people. The worst affected areas would be the North West and South West of Jakarta."

Stakeholder perception

All stakeholder groups perceive or frame air pollution as a challenge for Indonesian cities including national and international media (Jakarta Post News Desk 2017, Heryanto 2018, Vidal 2014b, Cochrane 2015), NGOs/civil society groups (Conservation International 2017), researchers (Handayeni 2013), policy makers/authorities (Indonesia Habitat National Team 2016) and others (GIZ 2021, UNEP 2015).

9.2 Climate change and its effects

Brief description on drivers and causes

Urban settlements produce emission, which besides polluting the air, also accelerate climate change. Climate change effects are problematic especially for cities. Drivers of GHG emissions are transport issues (e.g. increased motorisation rate, lack of alternative modes of transportation), open waste dumps, fossil fuel energy generation (in particular coal-fired power generation) and burning of forests. The latter results from Indonesia's palm oil industry, which, between 2001 and 2018, accounted for 7 per cent of global tree cover loss. Moreover, Indonesia's Land Use, Land Use Change and Forestry (LULUCF) emissions reached 1.6 GtCO2 in 2015, which corresponds to around 39 per cent of total global CO2 emissions arising from LULUCF (CAT 2019).

Impacts

The effects of climate change are worrisome for Indonesia. In particular the rising sea level affecting many of the country's coastal cities, brings the coastal population at risk, especially the lower-income population. Other ecological phenomena such as droughts and floods have negative implications on various sectors in the country such as agriculture and the country's food production industry. Around 30 per cent of the Indonesian population is employed in the agricultural sector (UNDP 2018). Hence, the consequences of climate change imply large negative socio-economic impacts on a country-wide level. Therefore, various programmes with respect to climate change adaption are already in place, such as the UNDP programme of Strategic Planning and Action to Strengthen Climate Resilience of Rural Communities (SPARC). Furthermore, forest clearance provokes not only large amounts of GHG emissions, but also results in losses of biodiversity, having negative socio-economic spill-over effects, for instance on Indonesia's tourism,

Affected cities

Indonesia's urban areas are affected directly by the consequences of climate change due to Indonesia's coastal location. A rising sea level is particularly concerning for urban areas in close proximity to the sea, facing the problem of flooding and landscape erosion. A projection of Climate Central (2019) forecasts that by 2050, around 23 million Indonesians, including large parts of Indonesia's capital Jakarta, will be living below average flood levels and therefore, being highly vulnerable to flooding and inundations.

Stakeholder perception

All stakeholder groups perceive or frame climate change and its effects as a challenge for Indonesian cities including national and international media (Kasdiono 2014 , Jong 2015, Vidal 2014b), NGOs/civil society groups (WWF 2018a), researchers (Mersmann, et al. 2017, Rukama 2009), policy makers/authorities (Indonesia Habitat National Team 2016) and others (ADB 2010).

9.3 Water pollution and availability

Brief description on drivers and causes

Water pollution is a problem detected for rivers, groundwater resources, maritime / coastal waters. Water pollution is caused primarily by urban settlements and affects urban waters as well as non-urban waters. Apart from that, non-urban settlements through mining pollute waterways affecting cities (Indonesia Habitat National Team 2016).

In Indonesia, there is a low awareness regarding water pollution, which is why households – and the literature emphasises the role of riverbank dwellers – as well as the industry dumps waste into rivers. Groundwater resources are over-extracted (Sherwell 2016). Apart from that, water catchment areas are in retreat due to demand for land from the construction sector (Rukama 2009b).

Impacts

Poor water quality is a problem for the urban poor. Even if access to water is available, the water quality for the urban poor is low. Polluted water can result in substantial health problems. Moreover, dirty water affects maritime coastal water (as well as coastlines), which in turn results in a loss of biodiversity (MoEF 2015). Solid waste polluting urban waterways also affect the drainage system of urban areas, which is why cities become more vulnerable to extreme weather events / floods. Water extraction from porous ground (e.g. Jakarta) as a result of lacking availability / piped water also results in land subsidence.

Affected cities

This problem is a national problem for urban areas in Indonesia and particularly challenging for the urban poor including slum areas and riverbank dwellers (Kooy & Furlong 2018). In general, a large degree of the literature screened focuses on Jakarta.

Stakeholder perception

All stakeholder groups perceive or frame water pollution and availability as a challenge for Indonesian cities including national and international media (Kooy & Furlong 2018, Aditya 2016, Sherwell 2016), NGOs/civil society groups (WWF 2018b), researchers (Rukama 2009b, Bakker & Kooy 2012), policy makers/authorities (Indonesia Habitat National Team 2016; MoEF 2014) and others such as donors (ADB 2016). According to the WWF (2018b) water pollution and availability has become a primary concern for many donors, such as ADB, World Bank, Coca Cola and Danone.

9.4 Noise pollution

Brief description on drivers and causes

Desk research finds that the limited literature that is available on noise pollution in Indonesia focuses on the increased use of private cars or motorbikes (Presatyo 2016, GIZ 2018), air planes (Sondakh et al. 2014) and industrial noise emissions (Uletika et al. 2016). Obviously, this does not mean that noise emission from railroads or leisure-time noise do not exist.

Impacts

Information on the impacts of noise pollution in Indonesia is limited. However, in fact, the consequences of excessive noise may harm human health and affect activities at work or school (WHO 2018). Noise is considered to influence negatively people's wellbeing, their quality of living and may deteriorate hearing performance (UBA 2015).

Affected cities

Data is limited in how far certain cities are affected. GIZ (2018) states: "growing motorisation […] puts intense pressure on medium-sized and major cities. Consequences include air pollution, land consumption, traffic congestion and noise – and not just in megacities such as Jakarta, but also in cities with around 200,000 inhabitants."

Stakeholder perception

Noise pollution appears to be rather an issue for donor agencies in order to provide argumentation for intervention (GIZ 2021, GIZ 2018). But there are also other sources suggesting that stakeholder draw attention to the challenge of noise pollution (Presatyo 2016, Sondakh et al. 2014, Uletika et al. 2016).

9.5 Loss of biodiversity and destruction of the natural landscape

Brief description

This environmental challenge is detected for urban and non-urban areas and includes aspects relating to a) the destruction of non-urban (rain)forests due to e.g. the urbanisation of fringe areas such as paddy field farm land is converted to urban land forcing farmers to go to highly biodiverse areas (GoI 2016), b) the destruction of coastal waters (particularly highly biodiverse coral reefs) due to polluted rivers, c) the destruction of natural riverbanks due to informal settlements in cities.

Impacts

Land conversion reduces carbon sinks and, if forests are burned, GHG emissions are set free. With respect to the destruction of coastal waters, one case is made with regard to Seribu Island, which con-tributes to Indonesia's tourism industry, mainly because of its richness in biodiversity (Guardian 2009). As urban settlements through waste production and water pollution affect the state of biodiversity negatively, touristic attractiveness is lost (ADB 2016). Riverbank residents reduce the ability of rivers to cope with floods and, thus, increase the risks of flooding in urban areas (Wijaya 2016).

Affected cities

Literature focuses on a limited amount of spaces (e.g. Jakarta, Wijaya 2016). Indonesia's Habitat III Report cites official statistics that each year more than 100.000 ha of agricultural land is converted into urban construction sites (Indonesia Habitat National Team 2016). Apart from that the report de-mands to "the increase of forest areas and urban biodiversity" suggesting that the loss of biodiversity in the context of cities seems to be rather a national issue than a local one.

Stakeholder perception

The loss of biodiversity is discussed within various stakeholder groups including international institutions (CBD n.d., ADB 2016). Its protection is tackled by the Indonesian government, such as in the Biodiversity Strategy and Action Plan for 2015 to 2020 (IBSAP, BAPPENAS 2016). The relation between urban development and biodiversity seems to be less prominently discussed although the Habitat III Report acknowledges the importance of biodiversity protection also in urban areas.

9.6 Land sealing and soil degradation

Brief description

Land sealing occurs mainly in urban areas. In Indonesia, land sealing continues within urban settlements not only sealing soil (reducing green open spaces) but also destroying dams or lakes. For in-stance, public open space, primarily green space, in Indonesian cities including Jakarta, Bandung, Me-dan, Surabaya and Semarang apparently declines, “from 35% in 1970’s to only less than 10 % in 2006” (Nasution & Zahrah 2014).

Impacts

Land sealing appears to be a high impact problem, because it results in a low resilience to extreme weather events such as floods (Rukama 2016). Evacuations, economic paralysis, the spread of diseases are some of the results (Vidal 2014b). Apart from that, the destruction of green spaces results in low living quality in cities. The urban heat island (UHI) has been influencing the average temperature in cities such as Jakarta, where the temperature increases of about 2°C have been measures in the last 50 years from June until August (Indonesia Habitat National Team 2016).

Affected cities

A nation-wide assessment has not been available. However, the environmental challenge of land sealing and soil degradation is a national challenge in most cities in Indonesia. As stated above, large cities suffer from a lack of green spaces. For instance, in Jakarta, around “50 percent of the watershed [of the Ciliwung river] is already converted to urban or agricultural land. Without the trees, grasses, and root structures needed to capture and water and hold soils the upper Ciliwung watershed's capacity to retain water from heavy rainfall has been drastically reduced. Consequentially, the downstream city of Jakarta now experiences less flood protection from this natural landscape“ (Hamzah 2017).

Stakeholder perception

Land sealing and soil degradation is discussed within all stakeholder groups reviewed including media (Süddeutsche Zeitung Online 2016, Vidal 2014a), civil society (The Jakarta Post/Parry 2014, Hamzah 2017), research (Rukama 2016), policy documents (Indonesia Habitat National Team 2016) and other sources (OECD 2016). Mostly, the issue comes up in combination with describing some of the consequences of land sealing including floods.

9.7 Land subsidence

Brief description

Due to excessive groundwater extraction, decreasing groundwater levels, heavy constructions on densely populated urban areas, natural consolidation of alluvial soil and geotectonic subsidence, land subsidence affects urban agglomerations in Indonesia (Abidin et al. 2011)

Impacts

A central issue related to land subsidence is that cities become less and less likely to deal with floods because lower levels of land exacerbate rainwater to drain off to the sea. Land subsidence in Semarang (and other Indonesian cities) has been leading to severe and costly damages to urban infrastructure such as buildings, roads and railway tracks. As a consequence, flooding hits the city frequently and is increasingly severely affecting the living conditions especially of the poorer urban population. In Semarang, 840,000 people live in the low elevation coastal zone and, thus, are vulnerable to floods and a rise of the sea level (Mulyana et al. 2013).

Affected cities

The issue is affecting Indonesia's urban agglomerations. Due to their location, coastal cities are affected in particular (Indonesia Habitat National Team 2016). Abidin et al. (2011) state for instance, that there is a direct relationship between land subsidence and urban developments in Jakarta, due to its rapidly increasing population, and the increase in sectors including industry, transport, trade and others.

Stakeholder perception

Land subsidence has been discussed among most stakeholder groups identified including media (Kusumwijaya 2016, Süddeutsche Zeitung Online 2016), policy makers (Indonesia Habitat National Team 2016), research (Saputra et al. 2017, Chaussard 2012, Mulyana et al. 2013) and other sources (OECD 2016).

9.8 Waste generation and management

Brief description

Urban settlements produce large amounts of solid waste. However, waste production in urban centres also has negative effects on non-urban areas (e.g. maritime waters). Apart from solid waste, industrial areas dump waste into rivers. Only around 70% of the urban population (135 million) do have access to waste collection services and approx. 55% of urban solid waste is collected, managed and treated at a transfer station or processing facility (World Bank 2017).

Impacts

Waste can be considered a major problem in Indonesian cities since it contributes to GHG emissions (including uncontrolled burning of waste), water pollution, health problems, smells and the spread of diseases. In addition, waste in rivers increases the risk of floods because waste reduces the water carrying capacity in rivers – 80% of river pollution is caused by domestic waste (ekonid 2016).

Affected cities

The performance of urban waste management services differs from city to city. Good performers with high collection rates of 80% or more have established recycling schemes and allocate a certain share of the local budget. However, there are cities with abysmal collection rates below 20% and hardly any visible political commitment (World Bank 2017).

Stakeholder perception

Waste generation or waste management is discussed among most stakeholder groups including media (Vidal 2014b, Hodal 2011, Soma 2014), civil society (WWF 2018c), research (Bunnell 2013), policy (MoEF 2015) and other sources (KfW 2017, World Bank 2017).

9.9 Summary

Based on the above analysis, the following conclusions can be drawn:

- The most prominent themes in the context of urban environmental protection discussed in the country and about the country are air pollution, climate change, water pollution and waste generation. The issues of land subsidence and land sealing are also important. While the loss of biodiversity is significant on the national level, it is of lesser relevance in the context of urban areas.
- Urban areas can be held responsible for most of the environmental damage caused. For instance, air pollution in cities is largely because of increasing motorised transport.

- Urban areas also contribute to environmental damage in non-urban areas, e.g. through the pollution of rivers or land use change.
- Non-urban areas hardly contribute to environmental challenges in cities. However, for instance, the burning forests can affect air quality in cities.

The following Table 10 summarises the conclusions, employing the five categories to evaluate environmental challenges at the urban level as developed in the methodology section.

Table 10: Summary of extent of environmental challenges at the urban level in Indonesia

Environmental challenge	Main drivers	Significance of challenge
Air pollution	Waste, Fire, Transport, land sealing, heating	Very high: all stakeholders discuss it, all urbanised areas are affected, 90% of air pollution results from transport and transport is a political priority
Climate change and its effects	Transport, urban sprawl, energy consumption, waste	Very high: all stakeholders discuss it, all urbanised areas are affected, diverse effects of climate change
Noise pollution	Transport and other noise emitters	Low: only experts discuss it, only matter of discussion in some cities
Water pollution and availability	Land sealing, water management/governance, soil compression	Very high: all stakeholders discuss it, most urbanised areas are affected, this is described as significant problem for the urban poor
Loss of biodiversity and destruction of the natural landscape	Water pollution, Land use	Medium: only experts discuss it, only matter of discussion in big cities, only rarely mentioned as challenge of urban development
Land sealing and soil degradation	Urban sprawl, Transport, Demand for housing space	Medium: international media and experts discuss it as a problem mainly in the biggest cities, as these continuously reduce their green areas
Land subsidence	Land sealing, water management	High: Media, experts, some politicians in Jakarta, its a challenge in coastal cities
Waste generation and waste management	Waste management, Awareness	Very high: all stakeholders discuss it, all urbanised areas are affected, international organisations aim to help

Source: Own compilation, Wuppertal Institute.

10 Political priorities in Brazil

This section describes principal areas of national action and their evolution. Jair Bolsonaro, the new elected president of Brazil, has shown his intention to modify the national environmental policy drastically with potential effects in many on the urban environmental challenges addressed in this document. Thus, before going in depth about the thematic policies, an overview of the main changes carried out by Bolsonaro in his first year in office will be provided.

One of Bolsonaro's main promises during his campaign was the reduction and restructuring of the administrative structure of the national government. Accordingly, the corresponding Provisional Measure (MP) and decrees to allow the formal attributions of the ministries to be changed were issued during the first days of his term in office, producing the most drastic restructuring of the top-level bodies since 1990 (ISA, 2019).

One of the most affected ministries was the Ministry of Environment (MMA), which Bolsonaro wanted to merge with the Ministry of Agriculture. However, due to the negative repercussions of this decision on the population, the media and also internationally, the government maintained the MMA (Figueiredo, 2019). However, the new structure of the MMA has significantly decreased its capacity to formulate and implement policies, including the establishment of environmental standards and guidelines. The MMA has not only lost political power, but is now subordinated to economic interests and other areas of administration (ISA, 2019).

The actions carried out in detriment of the environment go beyond MMA's structure. In less than one year in power, the Brazilian president has made it clear that Brazil's role as an agricultural export country interests him much more than that of environmental preservation (Gortázar, 2019).

Here a list of the main measures that show that Bolsonaro's policy framework threatens several environmental advances made in the previous decades (Tuffani, 2019):

- Elimination of the Climate Change and Forests Secretariat in the MMA
- Elimination of the Department of Environment, Energy and C&T of the Foreign Affairs Ministry
- Transfer of the Brazilian Forest Service (SFB) from the MMA to the Ministry of Agriculture
- Transfer of the National Water Agency (ANA) from the MMA to the Ministry of Regional Development
- Reduction of the number of counsellors of the National Environmental Council (Conama) from 96 to 23, with a huge impact on the representation of NGOs and federal states. Moreover, the private sector will have in the collegiate the National Confederation of Industry and the National Confederation of Agriculture (Trisotto, 2019).
- Militarisation of the leading positions of the Chico Mendes Institute for the Conservation of Biodiversity (ICMBio)
- Elimination of the advisory board of the Fundo Amazônia, a fund created in to reduce deforestation, which has aggravated the diplomatic crisis with Germany and Norway, main donors of the fund.
- One of the actions of the first 100 days of Bolsonaro's administration was the signing of a decree that would end the "spree of environmental fines": it would make the collection more

agile and convert the fines into actions for recovery and preservation of the environment (Trisotto, 2019).

This set of measures led previous environment ministers to accuse the current government of dismantling the progress made over the past 27 years. Since 1992, when Brazil hosted the first UN conference on the environment there has been a process of institutionalisation of a sound environmental policy, by which Brazil became a leading country, especially with regards to climate policy. (Gortázar, 2019).

With regards to the latter, Bolsonaro signalled that the country could withdraw from the Paris Agreement. However, as staying in the Agreement was fundamental to sign the free trade agreement between the European Union and Mercosur, Brazil's withdrawal was not possible (Trisotto, 2019). Notwithstanding, Bolsonaro has conducted several actions to dismantle the Brazilian climate change policy, including the elimination of the responsible body and a budget reduction of 95%.

In terms of the national urban policy, there have also been some changes. At the administrative level, the Ministry of Cities, founded in 2003 to specifically address urban challenges, has been merged with the Ministry of National Integration to create the Ministry of Regional Development (Câmara dos Deputados, 2019).

Moreover, one of Bolsonaro's strategic activities is the creation of the National Agenda for Urban Environmental Quality, defined with the objective of improving the indicators of good environmental quality in cities. After the consolidation of several diagnoses, six lines of action were established as initial goals of this government: Ocean Pollution, Solid Waste, Green Urban Areas, Air Quality, Sanitation and Water Quality, and Polluted Areas (MMA, 2019).

10.1 Air pollution

Policy formulation and implementation

The first air pollution control was introduced in 1976, establishing national air quality standards. In 1981, the National Environmental Council (CONAMA) was established, becoming the main actor with regards to air pollution regulation and setting the maximum tolerable concentrations of emissions in 1990 (IEA Clean Coal Centre 2016). The CONAMA resolutions entail various regulations.

Most significant amongst them is the National Air Quality Programme (PRONAR, 1989), promoting air pollution control by implementing strategies for national air pollution standards, discussing policies on the prevention of air pollution and implementing a national framework to monitor air quality standards (IEA Clean Coal Centre 2016).

PRONAR includes various other programmes such as the Programme for the Control of National Industrial Pollution, the Programme for the Control for Motorcycles and Similar Vehicles Pollution, the National Air Quality Evaluation Programme and the National Programme for Control of Air Quality which sets national standards on air quality and emissions and develops policies on the prevention and implementation of air pollution mitigation policies (IEA Clean Coal Centre 2016). Finally, PRONAR includes the Programme for the Control of Automotive Vehicles Pollution (PROCONVE). The latter is considered particularly successful since it established "phases in which maximum emission limits are defined for each typology of vehicles, so that only vehicles that meet those emission limits may be traded in the Brazilian market" (Federal Government of Brazil /IPEA/MP, 2016). According to the Habitat III report, PRONAR improved Brazil´s air quality in terms of diseases stemming from air pollution.

Moreover, more than 40 years ago, the Brazilian government implemented a programme to promote the production of alternative fuels such as bioethanol for vehicles. In 1975, Brazil launched the Programme for the Promotion of the Production of Biofuels (ProAlcool). In 2002, the Biodiesel Program (Probiodiesel) was also introduced, based on a large soybean availability and aiming at the creation of new fuel markets, encouraging global demand for renewable fuels as well as the reduction of CO2 emissions (Flexor, 2016). In 2004, the National Programme of Biodiesel Production and Use (PNBP) was introduced.

Whereas the aforementioned policies regulate air quality at the national level, national air quality standards come only into play when local limits are not defined (TransportPolicy, 2018). Curitiba, for instance, introduced a pollution control program in 1999, under which the population is only allowed to use their vehicle 6 days a week.

Internationally, Brazil has signed the Regional Action Plan for Intergovernmental Cooperation on Air Pollution for Latin America and the Caribbean in 2014. The plan entails the short, medium and long-run reduction targets of air pollution as well as the mitigation of GHG emissions and their global, national and local effects. By signing the plan, Brazil has committed to implement it into its national agenda.

In 2019, as part of the National Urban Environmental Quality Agenda, Bolsonaro launched the national air pollution monitoring network for analysis of pollution in urban centres, which aims at having at least one monitoring station in each state capital (Figueiredo, 2019). At the same time, the UN Environment *BreatheLife* Campaign was launched in Brazil in partnership with the PAHO and WHO (Pan American and World Health Organisations). The campaign, which has the support of the MMA and the Ministry of Health, seeks to encourage cities to implement programmes that protect human health and the environment from the harmful effects of air pollution (Cordeiro, 2019).

Responsibilities

As a cross-sectional issue, various agents are in charge of regulating and controlling air pollution in Brazil. The Ministry of Environment in general regulates the environmental law in Brazil. CONAMA advises government guidelines on resource and environment management as well as setting air quality standards. The Ministry of Science, Technology and Communication is in charge of the monitoring, reporting and verification of GHG emissions by pollutants (Climate Regulation Brazil, 2017).

10.2 Climate change and its effects

Policy formulation and implementation

Since the Rio de Janeiro Earth Summit, the UN conference hosted by Brazil in 1992, a process of institutionalisation of a sound environmental policy started, by which Brazil became a leading country, especially with regards to climate policy (Gortázar, 2019).

The main policy on GHG emissions mitigation is the National Policy on Climate Change (NPCC) which was published in 2010. It describes how Brazil´s government wants to achieve its commitment to the international climate targets as well as concrete action plans such as setting targets for emission reductions (MMA 2010). The National Plan for Climate Change comprises 8 sectoral plans which are designed in more detail and directed towards 8 different sectors:

1. Low-Carbon-Agricultural Plan (ABC-Plan)
2. Sectoral Climate Mitigation Plan for the Consolidation of a Low Carbon Economy in the Manufacturing Industry
3. Low Carbon Emissions Mining Plan (PMBC)

4. Sectoral Plan for Transport and Urban Mobility for Climate Change Mitigation (PSTM)
5. Sectoral Health Plan for Mitigation and Adaption to Climate Change
6. Action Plan for Prevention and Control of the Legal Amazon Deforestation (PPCDAM)
7. Action Plan for Prevention and Control of Deforestation and Forest Fires in the Cerrado region (PPCerrado)
8. Decenal Plan of Energy Expansion (PDE)

A 9th plan, namely the Steel Emission Reduction Plan is currently being drafted.

In terms of mitigation strategies for Brazil´s agricultural emissions, the Sectoral Plan for Mitigation and Adaption to Climate Change for the Consolidation of a Low Carbon Economy in Agriculture (ABC-Plan) was introduced in 2015. The ABC-Plan includes measures with regards to sustainable agricultural activities, such as "no-till agriculture, the restoration of degraded pasture, the planting of commerical forests, biological nitrogen fixation, treatment of animal wastes and the integration of crops, livestock and forest" (CCAFS n.d.). Since agriculture is responsible for the mejority of GHG emissions in the country, this plan is of particular importance (Climate Regulation Brazil, 2017).

Moreover, in its Nationally Determined Contributions (NDC), Brazil commits to reduce its GHG emissions by 37% below 2005 levels by 2025. The NDC also contain a subsequent indicative contribution to GHG emissions reduction by 43% below 2005 levels in 2030. Compared to the 1990 levels these two targets translate to 6% and 16% reduction, respectively. With these targets Brazil has positioned itself as the first major developing country to commit to an absolute GHG reduction below 1990 levels. In 2012, Brazil reduced its emissions by 41% compared to 2005 levels thanks to its efforts to decrease the deforestation rate (Yeo, 2015). In its NDCs, the following is stated: "In the period 2004-2012, Brazil's GDP increased by 32%, while emissions dropped by 52 %, delinking economic growth from emission increase over the period, while at the same time Brazil lifted more than 23 million people out of poverty" (Federative Republic of Brazil n.d.). Moreover, according to data from 2018 84% of the electricy generated in Brazil comes from renewable sources, mostly from hydropower (SEEG - Monitor Elétrico, 2018)

At the local level, municipalities are quite active in implementing actions that contribute to mitigating GHG emissions. According to the WorldBank Group (2010), Brazilian cities have led the process of setting GHG emissions reduction targets and adopting local climate action plans or strategies. For instance, Belo Horizonte introduced the Sustainable Urban Mobility Plan, which consists of elements such as a integrated public transport network composed of metro lines and a bus rapid transit (BRT) system; a bikeway network with the installation of protected bike lanes and a public bicycle sharing system. The BRT system was expected to cut travel times significantly compared to the previous bus system and to provide a safe and comfortable inner city transport means (Arioli et al. 2018). Nevertheless, concrete and comprehensive mitigation actions with respect to direct impacts of climate change cannot be analysed since only a small number of cities has taken action in that context (The WorldBank Group, 2010). Although in 2008 the National Climate Change Plan was introduced, calling for the assessment of urban vulnerabilities to the consequences of climate change, no comprehensive result has been published (The WorldBank Group, 2010).

According to CAT (2018), however, in the past years the Brazilian government has taken a reverse position with regards to its environmental commitments and its NDC targets. It has introduced, for instance, financial curtailments to crucial institutions such as a 50% budget cut to the Environmental Ministry and a 70% to deforestation monitoring authorities. As a consequence, GHG emissions are expected to rise in almost all sectors until 2030.

Responsibilities

The Ministry of the Environment (MMA) in general was in charge of formulating and implementing national public environmental policies. However, with the new administrative structure implemented by Bolsonaro, one of the most symbolic measures was the removal of part of the attributions of the former Secretariat of Climate Change and Forests of the MMA, including the climate agenda (ISA, 2019).

CONAMA advises government guidelines on resource and environment management as well as setting air quality standards. The National Fund on Climate Change and the Amazon Fund are mainly responsible for financing mitigation actions to reduce GHG emissions. The Brazilian Climate Change Forum aims at encouraging a social dialogue on challenges arising from GHG emissions. It also aims to support the government with the implementation of its policies. The Ministry of Science, Technology and Communication is responsible for dictating the monitoring, reporting and verification processes of GHG emissions by pollutants (Climate Regulation Brazil, 2017).

Under the government of Jair Bolsonaro (PSL), resources for initiatives to implement the National Policy on Climate Change were cut by R$ 11.2 million, equivalent to 95% of the budget cut. The decrease in resources is the result of the contingency of R$ 187 million in the Ministry of the Environment (MMA). The actions aimed at combating climate change will have only R$ 500,000 available for the entire year (Pina, 2019).

10.3 Water pollution and availability

Policy formulation and implementation

Considering rising agricultural and industrial activities, urban waste disposal and other potential threats related to water pollution, Brazil has reformed its regulations with regards to water management substantially on a federal, state and local level, acknowledging water as a finite resource. This section will highlight the policies that have been developed with regards to water and soil pollution.

As a foundation for water management, in 1997, the National Water Resources Policy (NWRP) and the National Water Resource Management System (NWRMS) were established by the National Water Law, reforming administrative, legal and institutional aspects of Brazil´s water management system (BERST, n.d.). The National Water Law also set the foundations for water resource planning and the introduction of a decentralized and participatory system of national water management. This system includes five types of institutions:

- The National Water Resources Councils (NWRC), which are in charge of developing strategies for the institutional basis of NWRP as well as for resolving conflicts over water basins at the national level.
- The State Water Resources Councils (SWRC), which are in charge of developing strategies for the institutional basis of NWPR as well as for resolving conflicts over water basins at the state level.
- The State Water Resources Management Institutions (SWRIs), which are in charge of implementing the strategies of SWRC
- The River Basin Committees (RBCs) which represent “water parliaments”, playing a fundamental role in solving disputes, monitoring water management at rivel basin level and decentralized management of water resources
- And finally, the Water agencies (WAs).

In addition, the National Water Agency (ANA) was created to be in charge of implementing NWRP and monitoring the disposal of wastewater into water basins. In 2016, 27 SWRCs and over 200 RBCs have been established (Libanio, 2017). However, the idea of this participatory model is less successful than expected due to a lack of enforcement mechanisms and public participation (Ioris 2008; Libanio, 2017).

With regards to water quality standards and water access, the basic laws include Law No. 11.445/2007 which calls for the implementation of universal access to potable water supply, sanitation/sewage, urban sanitation, solid waste management and rain drainage, and urban stormwater management (Federal Government of Brazil, National Secretary of Environmental Sanitation and Ministry of Cities, 2010). In additon Law No. 7.217/2010 regulated drinking water and wastewater collection and treatment. They represent the basis for Brazil´s National Basic Sanitation Plan (PNSB or Plansab), approved in 2013, which contains short-, medium- and long-term regulations with regards to basic sanitation planning, draining and management of storm water, and universal basic sanitation services, which are largely to be implemented at the municipal level (Federal Government of Brazil/IPEA/MP, 2016). This is also the reason why Brazil´s santiation system is considered to be decentralised. However, in 2015, only 31 per cent of the municipalities had adopted their santiation plans, whereas in 2023, only 51 per cent of municipalities are expected to implement their plans (Romano and Gammeltoft, n.d.). Moreover, the PNSB is criticized for not considering environmental issues that are not directly connected to sanitation, such as the impact of spatial developments on water scarcity, or the effect of industrial and agricultural activities on water resources (Romano and Gammeltoft, n.d.).

In general, Brazil´s water and sanitation management system is very complex, involving a large network of institutions, organisations and stakeholders. Although the current decentralized and participatory model could be theoretically highly effective in reaching Brazil´s water-policy targets, there are several challenges that need to be resolved and it has not reached its full potential.

It is worth noting that, under Bolsonaro's administration, in the first half of 2019, 239 pesticides were released by the Ministry of Agriculture, including at least 14 substances banned in other countries (Figueiredo, 2019).

Responsibilities

Setting and monitoring water quality standards as well as implementing the PNSB is a responsibility shared by various authorities in a decentralized system. Municipalities are in general responsible for the supply of potable water as well as for the access to sanitation services. Moreover, they are responsible for the planning, provision, organisation, regulation and controls. They are also in charge of setting the corresponding fees and avoiding the monolopolisation of water sources (Romano and Gammeltoft, n.d.). Municipalities may, however, delegate responsibilities to the states. However, no concrete informationis have been published on the number of municipalities where such delegations have taken place.

Nationally, the National Water Agency (ANA) supervises the use of water resources and the discharge of wastewater into rivers. The Ministry of Health coordinates the National Drinking Water Quality Surveillance Programme as well as the coordination of the decentralized system with regards to local responsibilities and delegation of responsibilities. The National Department of Enviornmental Sanitation (SNSA) is in charge of providing universal access to potable water and sanitation. Moreover, the former Ministry of the Cities (MCidades) was in charge of developing strategies and guidelines for the conservation of urban water systems as well as for urban water treatment subject to sanitation standards for municipalities with more

than 50,000 residents. Meanwhile, the National Health Foundation is responsible for strategies for municipalities with less than 50,000 inhabitants (American National Standard Institute n.d.).

Under the new administrative structure, the management of the NWRP is no longer one of the mandates of the MMA. It, including the National Water Agency, was transferred to the Ministry of Regional Development (previously, Ministry of Cities) (ISA, 2019).

10.4 Loss of Biodiversity

Policy formulation and implementation

This section reveals Brazil´s political commitments with regards to biodiversity. It first gives an impression over the policies and regulations that were introduced during the past two decades and then sheds critically light on the introduction of the Biodiversity Law (Law 13.123/2015).

Various political and regulatory benchmarks have been introduced during the past two decades, defining large-scale sustainable public policies (see Table 11).

Table 11: Timeline of Political Benchmarks with regards to Biodiversity

Date	Policy
1994	Brazil ratifies the international Convention on Biological Diversity (CBD) including Aichi-Targets
2002	National Biodiversity Policy
2003	National Biodiversity Commission (Conabio)
2010-2012	Dialogues on Biodiversity: Discussion and consultation processes
2013	National Biodiversity Strategy
2014	Brazilian Panel on Biodiversity (PainelBio)
2015	Biodiversity (Law 13.123/2015)
2016-2020	National Biodiversity Strategy and Action Plan (NBSAP)

Source: Own compilation, Wuppertal Institute.

Among these, the NBSAP is the main instrument for the implementation of the CBD and it includes four priority pillars:

1. Supporting genetic heritage and traditional knowledge
2. Conservation of protected areas
3. Conservation of ecosystems and promotion of sustainable landscapes management
4. Conservation of threatened species

Recently, Brazil has, nevertheless, introduced various policies that raise a number of questions with regards to its long-term sustainable biodiversity goals.

First, a new law on biodiversity (Law 13.123/2015) was introduced, intending to enable easier access to genetic resources, traditional knowledge and ethnobiological research without prior federal authorization. This law has raised extended criticism among national human rights organisations, community initiatives and traditional/indigenous groups. According to them, it is providing economic benefit to pharmaceutic and large agricultural enterprises mainly because it provides easy access to genetic heritage. At the same time, it barely involved, nor consulted farmers, indigenous and traditional communities throughout the construction process

(Dallagnol et al. 2016). Second, recent budget cuts "radically affected research programs on biodiversity that are crucial components for the design and monitoring of public policies for nature conservation and sustainable development" (Fernandes et al. 2017). For instance, the budget of the Ministry of Science, Technology, Innovation and Communications (MCTIC) has been decreased by 44% in 2017 compared to 2004, which also affects its Research Programme on Biodiversity (PPBio), representing Brazil´s largest biodiversity research programme. Consequently, the generation of new knowledge is hampered.

Concluding, although Brazil has done considerable national and international efforts in maintaining a biodiverse ecosystem, recent political developments stand in contrast to its development of the NBSAP of 2016.

Responsibilities

The MMA is the institution in charge of elaborating and monitoring the progress on the National Biodiversity Policy. In addition, several non-state actors were involved in the construction and implementation of the NBSAP. Within the MMA the Biodiversity Secretariat (SBio) has the coordinating role and is supported by various agencies connected to the MMA, ministries and public enterprises, as well as state and municipal environmental agencies. Conabio and PainelBio act across all segments of society, responsible for the knowledge sharing, capacity-building and support of policy-making w.r.t. the Aichi-Targets. Brazil´s commitment to the CBD is monitored and evaluated by Conabio (MMA and Secretariat of Biodiversity 2016).

10.5 Land degradation and deforestation

Policy formulation and implementation

Brazil´s efforts to reduce deforestation activities in the country are based on the 2009 National Policy on Climate Change, where the Brazilian government acknowledges officially the need to reduce emissions stemming from deforestation activities in the Amazon and the Cerrado area. In fact, by 2020, the government tackles a reduction of deforestation measures of 80 per cent in the Amazon and of 40 per cent in the Cerrado.

In 2004, when deforestation activities experienced an unprecedented peak, the Brazilian government developed the Action Plan for Prevention and Control of the Legal Amazon Deforestation (PPCDAm), covering an area of 5 million km² which equals approximately 60 per cent of Brazil´s territory. The PPCDAm includes three main pillars, namely: "(i) land and territorial planning, (ii) environmental monitoring and control, and (iii) fostering sustainable productive activities" (MMA and Department for Policies against Deforestation, 2011). These three pillars require the participation of state and municipal authorities. Therefore, municipalities with high rates of deforestation are ranked in a list according to their share of deforestation in the region. To be removed from the list, municipalities have to proof that they commit to maintain the rate of deforestation at a maximum level of a fixed terrestrial area determined by the authorities (e.g. 40 km² during 2008/2009). Another important target of the PPCDAm is the establishment of an environmental register for rural properties.

The PPCDAm has been divided into three implementation phases. From 2004-2007, deforestation should be reduced by 20 per cent. From 2008-2011, measures to reduce deforestation by 80 per cent up to 2020 relative to the baseline of 1996-2005 should be introduced. The final phase from 2012-2015 emphasizes capacity building with respect to the territorial planning and development as well as sustainable agricultural practices (PPCDAm). The implementation of the second phase is currently in process. A similar plan exists for the

Cerrado region (PPCerrado). The success of these plans with regards to a reduction in deforestation is proved by various studies (e.g. Aubertin 2015).

Brazil was also the first country to develop a robust methodology for monitoring changes in vegetation cover in the Amazon region, which was then replicated in other countries with tropical forests, through training programs conducted by the National Institute for Space Research (INPE). In the 1970s, the country began to develop satellite image-based technologies to monitor natural resources and changes in the vegetation coverage of the national territory (Congresso Em Foco, 2019).

Moreover, in 2009, Agricultural Zoning was introduced on a federal level, considering "direct and indirect effects of land-use change caused by the expansion of sugarcane in Brazil" (Almeida, 2012). It defined the terrestrial areas where sugarcane can be produced and restricted private and public subsidies only to sugarcane areas within the specified zones. As such, it prohibited sugarcane to be cropped at native land. Almeida (2012) mentions, however, some shortcomings of agricultural zoning in Brazil. For instance, the Cerrado Biome is not considered as native land under the Agricultural Zoning Regulation and, thus can be used as crop land for sugarcane production. Moreover, companies that were authorized to expand sugarcane production before the implementation of the agricultural zoning regulation in 2009, are allowed to further expand even in native lands. On November 2019, the 2009 decree that introduced the agricultural zoning was revocked by Jair Bolsonaro under the argument that it was an obsolete regulation and that the Forest Code already covered it (Farias, 2019a).

The first Forest Code approved in 1965 and in force until 2012 established a series of restrictions by which the owners of land in the Amazon region were able to use only 20% of the area and had to preserve the other 80%. The new Forest Code (Law 12.651/2012) reviewed in 2012 reduces the preservation restriction to 50% if more than 65% of the owned land is located in protected areas or indiginous territories (ABC Biodiversidad 2019). It gave benefits to the owners of these areas, such as a reduction in the Permanent Preservation Areas (APPs) and the possibility of compensating Legal Reserve (RL) areas in another property. Those who deforested after that date have to comply to the new Code.

If the rules of the Forest Code are made more flexible, as provided for in MP 867, a Provisional Measure introduced by the former president Michel Temer at the end of 2018, the Forest Code Observatory estimates that between 4 and 5 million hectares of area that should be recovered will be lost. These areas will be consolidated as deforested. For this reason, Brazil would be even further away from the goal it assumed as part of the Paris Agreement of recovering 12 million hectares of native areas by 2030 (Domingues, 2019).

The MP 867 expired without been approved in Congress. However, the current government is now analysing whether to send another provisional measure on the subject to Congress or to urgently enact a bill. In both cases, the tendency is to present a text similar to what was approved by the House in the analysis of the MP that lost its validity (Domtotal, 2019).

In may 2019, Senator Flávio Bolsonaro, the president's son, proposed a Bill to eliminate the Legal Reserves - a protected area that cannot be deforested on rural properties - claiming the constitutional right to property, which could have reached a deforested area of 167 million hectares (30% of all native vegetation in Brazil)(Trigueiro, 2019). Given the strong controversy caused by the bill, it was withdrawn in august. At the same time, the national government created a task force group pro-Amazônia in order to come up with a series of initiatives that preserve the environment, but promote economic development at the same time. According to the minister, the intention is to create a multidisciplinary group, in which there is participation

of the government, companies with economic interests in the area -such as timber and mining companies- and organizations of the third sector (Schelp, 2019).

Furthermore, the Environment Minister Ricardo Salles announced the review of all the country's Conservation Units. According to the minister, the units were defined without any technical criteria and may be redefined or even eliminated (Trigueiro, 2019).

Moreover, the government's environmental policy and declarations have put at risk the million-dollar Amazon Fund, a system to reward efforts to preserve the Amazon and its biodiversity. If deforestation exceeds a certain limit, the European contribution will come to a standstill. In the space of a decade, Norway, Germany and Petrobras have earmarked 650 million euros to the Amazon Fund, managed and audited by Brazilian institutions for more than hundred projects. The Bolsonaro administration, on the other hand, has not approved a single project since January (Gortázar, 2019).

However, Bolsonaro has signed a joint initiative between the Ministry of Environment and the United States Agency for International Development (Usaid) for the creation of a $100 million fund for the economic development of the Amazon. The fund aims to provide long-term loans to private companies of timber and non-timber forest products that contribute to reducing deforestation, sustainability and improving the social condition of the local population (Figueiredo, 2019).

It is worth noting that the recent free trade agreement between Mercosur and the EU, which has been one of Bolsonaro's victories, includes green requirements such as that imported South American products do not come from deforested areas. In the case of soya from the Brazilian Amazon, there is an effective system agreed by the industry, the authorities and civil society that guarantees it. But right now it is impossible to offer that guarantee for products grown in areas with less legal and environmental protection (Gortázar, 2019).

Responsibilities

Responsibilities are shared on various levels. Monitoring deforestation was done on a federal level by the MMA and on a local level by municipalities. The MMA was, additionally, responsible for the establishment and implementation of environmental laws and regulations.

Created 30 years ago, Ibama had accumulated tasks of inspection, management of conservation units and environmental education activities. According to the National Institute for Space Research (INPE), IBAMA contributed to a 75% reduction in deforestation in the Legal Amazon since 2004 (Ramos, 2019).

Due to the restructuring process carried out by the government of Bolsonaro, the competence to combat deforestation, the core area of the Ministry of Environment (MMA for its Portuguese acronym) since the 1980s, was suppressed. Additionally, the MMA is no longer responsible for combating forest fires and desertification. (ISA, 2019).

Moreover, the transfer of the MMA's Rural Environmental Registry (CAR) to the Ministry of Agriculture (MAPA) is also considered problematic. The CAR was created by the new Forest Code to register the areas that may or may not be deforested and that need to be recovered in each property and rural land, enabling the inspection and punishment of irregularities (ISA, 2019).

Finally, two important inspection bodies, the Chico Mendes Institute for Conservation and Biodiversity (ICMBio) and the Brazilian Institute for the Environment and Renewable Natural Resources (Ibama) have been undergoing restructuring since the beginning of Bolsonaro's regime, who has adopted an alignment with agribusiness flags and ideas. In April, 2019, the

Ministry of Environment decided to cut Ibama's annual budget in 24%. With the cut, Ibama's budget was reduced from R$ 368.3 million, as stated in the Budget Law (LOA), to R$ 279.4 million. The fixed expenses of the agency alone are estimated at R$ 285 million. (Garcia, 2019).

10.6 Solid Waste Generation and Management

Policy formulation and implementation

An important benchmark in Brazil´s waste management system represents Law No. 12,305 which established a legal framework for a National Solid Waste Policy (PNRS) in 2010. The PNRS created the fundament for new mechanisms and systematized the realization of waste management in Brazil. Amongst others, it introduced the obligation for municipalities to establish Municipal Plans of Integrated Management of Solid Waste. Although the plans contains various ambitious targets, some studies show that it has not yet achieved the desired efficiency. Alfaira et al. (2017) show that the disposal of solid waste on sanitary landfills remained the main means of waste management in Brazil and that since 2015, household waste increased by further 1.7 per cent while population grew by 0.8 per cent.

After almost a decade of Law 12.305/10, only 3.053 municipalities declared to have Integrated Management Plans for Solid Waste. However, it is worth noting that in 2013 only 1,865 had a solid waste plan (SWP), covering a total population of 65 million , while today 130 million people live in cities that have a SWP. Also, the number of municipalities that currently take part in the National Sanitation Information System – Solid Waste (SNIS-RS) went from 108 to 3,670 between 2002 and 2016 (MMA, 2019).

The implementation of selective collection is under the responsibility of the service holders (Decree No. 7404/2010, article 9, paragraph 2) and should be carefully planned within the scope of the Municipal Plans for Integrated Management of Solid Waste (PMGIRS). In 2017, only 35% of the municipalities had a selective collection plan. In fact, 94.1% of the municipalities in the sample with more than 1,000,000 inhabitants had selective collection programs against 29.15% of municipalities with less than 30,000 inhabitants (MMA, 2019).

Waste pickers are an important part of the waste value chain in Brazil. It is estimated that there are between 400,000 and 600,000 waste pickers countrywide. Thus, the PNRS includes among its objectives, the integration of waste pickers in the actions that involve the shared responsibility for the life cycle of the products and indicates that the municipal plans of integrated management of solid residues must contain programs and actions for the participation of interested groups, especially cooperatives or other forms of association of waste pickers formed by low income individuals, if any (MMA, 2019).

The new Ministry of the Environment's main project to improve environmental quality in the first half of the year was inaugurated in March: the first phase of the National Urban Quality Agenda, entitled National Plan to Combat Oceans Pollution (PNCLM). Divided into 30 short, medium and long term actions, the plan aims to combat a global environmental problem, pollution in the oceans. Brazil has approximately 8,500 km of coastline, thus requiring an effective federal policy in this area (Figueiredo, 2019).

The second phase of the National Agenda for Urban Quality, called the National Zero Dumpsites Programme, aims to end one of the major environmental problems of the country, the dumpsters. It is worth mentioning that according to the PNRS all the dumpsites located in the 5,570 Brazilian municipalities had to be closed by August 2014. However, approximately 43% of Brazil's municipalities still dispose their waste inappropriately. To address this problem, the MMA launched this Programme to address the issue of solid urban waste by strengthening its

integrated management, selective collection, recycling, reverse logistics, energy recovery and environmentally appropriate disposal of waste (Figueiredo, 2019).

Responsibilities

Large responsibilities are delegated to the municipal level. The City Waste Management Authority of each urban centre is in charge of the collection and disposal of solid waste. Moreover, the city government supports the informal collection of garbage with the help of 72 waste picker organisations including and around 20 thousand informal waste pickers.

Under the government of Jair Bolsonaro, the budget for supporting the implementation of the National Solid Waste Policy fell by R$ 6.4 million, which is equivalent to an 83% cut in the program's budget (Pina, 2019).

10.7 Summary

Brazil is a presidential federal republic, composed of the Union, 26 states, the federal district and 5,570 self-governing municipalities that are administratively autonomous and considered as federal entities (OECD, n.d.).

Governance of environmental protection

Environmental responsibility is a shared competence among the federal government, the states, as well as the municipalities. Hence, environmental issues are handled at all three levels characterized by frequent overlaps of responsibilities (OECD, n.d.). At the federal level, Brazil has various ministries, whereas for this report certain ministries are of particular importance:

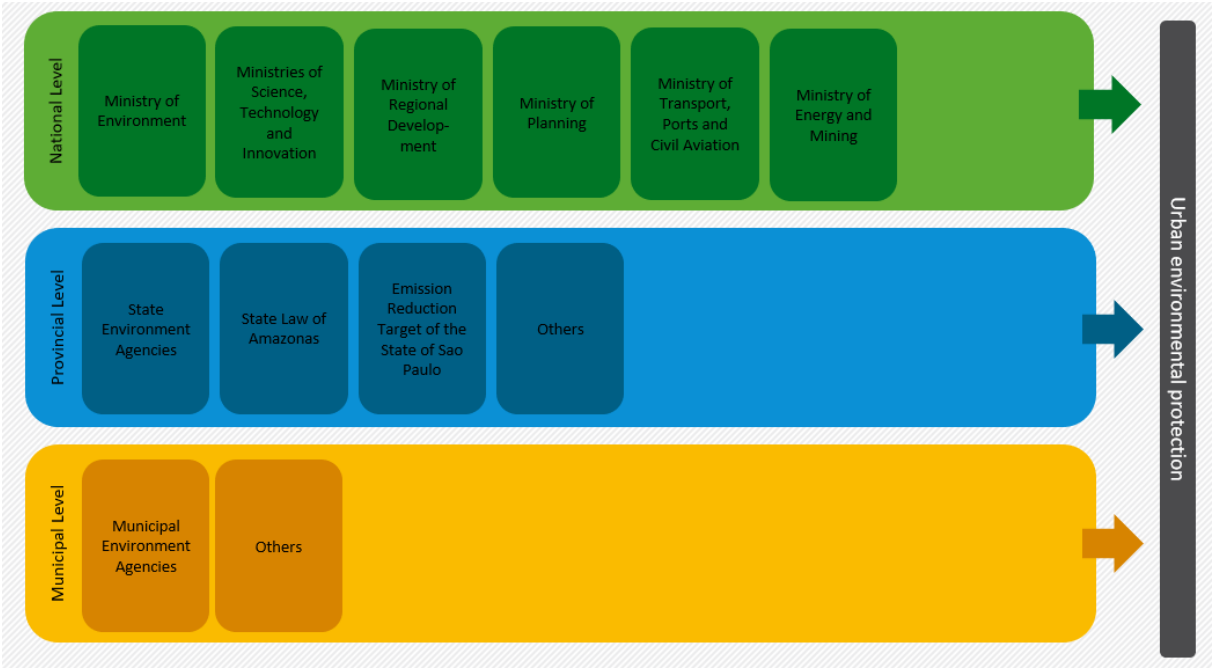
1. The Ministry of Environment is the main actor when deciding upon environmental policies in general, including all challenges that are mentioned section 4.1. It formulates and implements environmental policies. This might change with the restructuring process and budget cuts undergone by the current administration.
2. The Ministry of Science, Technology and Innovation in turn is in charge of more technical factors, such as monitoring and veryfing pollutant levels.
3. The Ministry of Cities was responsible for urban development policies as well as sectoral policies for public transport, sanitation and housing. It has been merged with the Ministry of National Integration to create the Ministry of Regional Development.
4. The Ministry of Planning is in charge of planning and executing social, urban, logistic and energy infrastructures, encouraging sustainable development.
5. The Ministry of Transport, Ports and Civil Aviation is responsible for the implementation of policies with regard to transport on railways, road, waterway and air.
6. The Ministry of Energy and Mining is in charge of policies with regards to geology, mineral resources, hydraulic energy, mining, fossil and renwable energy as well as nuclear power.

At the state level, state environmental agencies are in charge of environmental issues. Similarly to the federal level, the state level has three branches: executive, legislative and judiciary. Whereas the Brazilian constitution sets clear guidelines with regard to the divison of responsibilities among the federal and the municipal level, states “may carry out all functions that are not explicitly foreclosed to them” (OECD, n.d.). With regards to climate legislation, various state laws have been launched throughout the past decade, including for instance the state law of Amazonas or the approval of a 20% emissions reduction by 2020, compared to 2005 levels, by the state of São Paulo (Nachmany et al. 2015).

Municipalities have exclusive competences only in a few areas, such as in the provision of public services (e.g. primary education) and the management of urban planning (OECD, n.d.). Under Brazil´s Constitution of 1988 local authorities are guaranteed considerable autonomy with

regards to environmental issues. Through the establishment of this decentral system and the considerable degree of autonomy, "municipalities are free to establish their own environmental priorities and negotiate their participation in state and federal priorities" (Neves, 2016). Of course, such a decentralized system may involve benefits, but it may also be disadvantageous (e.g. lack of cooperation among the three governance levels), leading to inefficient long-term results. Moreover, municipalities are largely dependent on federal financial support.

Figure 7: Brazilian authorities in the field of urban environmental protection



Source: Own illustration, Wuppertal Institute

In the following, key national policies for each environmental challenge will be summarized and analysed with regards to their ambition and stringency. Priorities in the right hand side column will be based on an own assessment following the criteria mentioned in the Methodology section.

In that context it is important to mention that although Brazil is the first developing country which commited itself in 2016 under the Paris Agreement to reduce GHG emissions by 37% until 2030 and has set ambitious targets in the past years, recent political developments indicate that progress in national mitigation actions is hampered (Observatório de Clima, 2017). Since 2014 Brazil faces a political and economic crisis which has changed the priorities. Some of the policies implemented by the new elected president, Jair Bolsonaro, in his first year in office have been presented here. However, the impact of the measures that are already in place and the planned ones will only be shown in the years to come.

Table 12: National policy implementation regarding urban environmental challenges in Brazil

Challenge	Policies	Status and ambition	Priority
Air pollution	Program of National Air Quality (PRONAR)	Implemented, "considering the consequent progressive increase of atmospheric pollution, mainly in metropolitan regions" (Conama Resolution 5(89). It represents the legal fundament for subsequent successfully	High

Challenge	Policies	Status and ambition	Priority
		implemented CONAMA regulations.	
	Program of the Production of Biofuels (ProAlcool) 1975	Implemented, far-reaching consequences for automotive industry in the subsequent decades.	
	Biofuel Programm (Prodiesel)	Implemented, based exclusively on soybean production; ambitious targets such as creation of new oil markets, supporting global consumption patterns of alternative fuels and the reduction of CO2 emissions.	
GHG emissions and climate change	National Policy on Climate Change/ Law No. 12187 (2009)	Approved in 2008; Revised in 2014; implementation still in progress; ambitious targets (comprising almost all environmental challenges mentioned in section 4.1 as well as concrete action plans); includes 8 sectoral plans with more detailed mitigation action plans listed in the following; however, recent political decisions show reverse position of government	High
	Low-Carbon-Agricultural Plan (ABC-Plan)	Launched in 2013; Implementation still in progress, ambitious targets (e.g. restoration of degraded pasture, planting of commerical forests).	
	Decenal Plan of Energy Expansion (PDE)	Launched in 2013; Informative document which serves as the “main reference for the energy sector, a source of research data and academic developments and society in general, and exercising its role of technical study that points the way to the country´s energy development” (Ministério de Minas e Energia, 2017); timeframe with ambitious targets up until 2026 (e.g. technological development of more energy efficient vehicles, expansion of hydropower as well as renewable sources for energy generation).	
	Sectoral Climate Mitigation Plan for the Consolidation of a Low Carbon Economy in the Manufacturing Industry	Launched in 2013; Binding targets such as a 5% reduction target for industrial emissions until 2020.	
	Low Carbon Emissions Mining Plan (PMBC)	Launched in 2013; Binding targets including for instance forest restoration of degraded areas due to mining or the use of biomass in mineral transformation sectors (Esparta, 2016).	

Challenge	Policies	Status and ambition	Priority
	Sectoral Plan for Transport and Urban Mobility for Climate Change Mitigation (PSTM)	Launched in 2013; binding and ambitious targets (e.g. increase share of use of biofuels, increase low-emission transport, support of public transport infrastructures).	
	Sectoral Health Plan for Mitigation and Adaption to Climate Change	Launched in 2013; does not include any mitigation measures, but focuses on adaption actions instead (Esparta, 2016).	
	Steel Emission Reduction Plan	Currently being drafted.	
	Action Plan for Prevention and Control of the Legal Amazon Deforestation (PPCDAM), Action Plan for Prevention and Control of Deforestation and Forest Fires in the Cerrado region (PPCerrado)	See below in Soil Degradation and Deforestation.	
	Intended Nationally Determined Commitments (iNDCs) 2015	Implemented; Binding and ambitious targets (e.g. absolute emission target of 1300 million tons of CO2eq by 2025 and 1200 million tons of CO2eq in 2030, equivalent to a total reduction by 37% of emissions by 2025 compared to 2005).	
Water Pollution and Availability	Law No. 11.445/2007 and Law No. 7.217/2010	Implemented, but especially in North and Northeast of Brazil largely ineffective (Delpupo and Bueno, 2015).	Medium to Low
	National Basic Sanitation Plan	Delegating large responsibilities to municipalities; however, in 2015, only 31 per cent of all municipalities had adopted sanitation plans; moreover, it ignores other relevant issues such as the impact of spatial developments on water scarcity or the pollutant effect of industrial and agricultural activities on water quality.	
	National Water Resources Policy (NWRP)	Implemented, addressing water as a scarce resource, encouraging a decentralized system of water management, including river basins into water resource planning; 200 RBCs and 27 SWCs already established; however, system is still very fragile and full potential has yet to be reached.	
Loss of Biodiversity	Convention on Biological Diversity (1994)	Implemented, including Aichi-Targets	Medium to Low

Challenge	Policies	Status and ambition	Priority
	Biodiversity Law/ Law 13.123/2015	Not yet implemented, intended to encourage ethnobiological research by providing easier access to genetic resources and to provide benefit sharing; however, it neglects interests of certain groups, such as indigenous people	
	National Biodiversity Strategy and Action Plan (NBSAP)	Developed in 2016, yet to be implemented. Ambitious targets in particular w.r.t. genetic heritage, protected areas, sustainable landscape management and threatened species.	
Soil Degradation and Deforestation	National Policy on Climate Change/ Law No. 12187 (2009)	Implemented, ambitious targets (e.g. 80 per cent reduction of deforestation in the Amazon and 40 per cent in the Cerrado area); however 70 per cent budget cuts to monitoring authorities and upward trend in deforestation rates in 2016	Medium
	Action Plan for Prevention and Control of the Legal Amazon Deforestation (PPCDAM), Action Plan for Prevention and Control of Deforestation and Forest Fires in the Cerrado region (PPCerrado)	Binding targets; 1st Implementation Stage completed; 2nd stage in process (Gebara and Thuault, 2013); highly effective targets (e.g. priority list of municipalities, register for land tenure); however, recent trends show an increase in deforestation.	
	Agricultural Zoning 2009	Implemented by federal decree, based on three main areas: agricultural policy, environmental sustainability and food security (Almeida, 2012); however, includes large disadvantages that decrease its efficiency.	
Solid waste generation and management	National Solid Waste Policy (PNRS)/Law 12,305/2010	Implemented, including ambitious targets and transferring large responsibilities to municipal level; however, studies show that desired effect not yet achieved (although recycling in some areas, such as aluminium waste, is functioning efficiently)	Medium

Source: Own compilation, Wuppertal Institute

11 Political priorities in Russia

This section describes overriding areas of national action. The formulation of key national policies to tackle environmental challenges are analysed with a view to understand their ambition and stringency.

11.1 Air pollution

Policy formulation and implementation

Air pollution has been explicitly mentioned in the vast majority of the federal and regional socio-development and further strategic documents. There is no single strategy to tackle air pollution comprehensively on the federal level.

The overarching strategy to tackle air pollution in Russia is presented by "Clean Air", which is a sub-program of the national project "Ecology", running from 2019 to 2024 (National Project Ecology, 2018). "Clean Air", however, has a limited area of coverage since it tackles mainly the most polluted 12 cities in the country. The aim for those cities, including Bratsk, Krasnoyarsk, Lipetsk, Magnitogorsk, Mednogorsk, Nizhny Tagil, Novokuznetsk, Norilsk, Omsk, Chelyabinsk, i Cherepovets and Chita (Chita (see also section 5.1, figure 6 for geographic illustration)) is a 20% reduction of harmful emissions. Possible measures comprise the development and/or installation of air quality monitoring systems, the introduction of pollution permit systems for polluting companies located in or in close proximity to the respective cities, the development of low-carbon public transportation, as well as the regulation for polluting industries and coal generation facilities.

Another recent legislation reform in the area of environmental legislation prescribes new regulation for the industrial polluters. From 2019 onwards, the companies will have to start installing the Best Available Technologies, BAT (Amendment to the Federal Law on the Protection of Environment, 2014 and later). The books of reference for the BAT for various industries have been published in 2017-2018. Along with these, the companies would also have to install automatic emission control equipment which will broadcast emission data to the Rosprirodnazdor (The Federal Service for the Supervision of Natural Resources) and later on potentially also online (the data then would be publicly accessible). The ongoing reform is due to be implemented till 2025. At first it is the 300 most polluting companies (responsible for 80% of the air pollution in the country), their list is still being updated. However, the implementation of this reform has been substantially slowed down by 2020, caused be strong opposition of business (industrial) lobbyism.

By mid-2018 it has been reported (Sergey Ivanov, President's environmental advisor, speaking at the St. Petersburg Economic Forum in May 2018) that most polluting enterprises have already installed the best available technologies. However, it has not had a big impact on the air pollution in the industrialised urban regions of Russia (WWF n.d.). As a result, a number of local governments (including the government of the Chelyabinsk region in Southern Ural) have come up with an idea to introduce pollution permits for the companies (in addition to the BAT system). In July 2019, the law has been adopted, followed by two regional laws in Chelyabinsk and Magnitogorsk (December, 2019). Further regional legislations in all cities mentioned in the National Project "Ecology" will be introduced.

In the transport sector there is no single coherent federal level strategy of emission reduction. Although most of the large cities and regions in Russia have developed regional strategies addressing the issue, only some cities have actually developed urban strategies.

According to the media report, Ministry of Natural Resources and Environment, the Ministry of Transport and the Ministry of Industry and Trade are working out a strategy of sustainable transport for Russia (Kommersant, 06.12.2017). Some regions (including Moscow) are including sustainable transport/mobility aspects including targets of bringing down emissions from the transport sector into their city/regional development plans.

In 2016 Russia has introduced a Euro-5 standard for vehicles (based on the Agreement of the Customs Union with Belarus, Kazakhstan, Armenia etc) and in late 2019, it introduced a Euro-6 standard (On amendments to the technical regulation of the Customs Union 2019). It is prohibited to manufacture and to import new vehicles below the Euro-5 standard.

The driving regulations in Russia allow cities to introduce their own fuel standard zones (e.g. only allow Euro-4 or Euro-5 vehicles driving in city centres), however the city administrations have not actively been employing this regulation tool. In July 2018 new regulation came into force allowing regional authorities introduce special environmental or 'green' zones where only cars of particular emission standards (classes) will be allowed to. Confirmation of vehicle emission classes in the vehicle registration has only been introduced in Russia since 2012.

Moscow administration has introduced a ban for cargo trucks below the Euro-2 standard to drive on the Moscow Ring Road and for cargo trucks below the Euro-3 standard to drive on the Third Transport Ring. Both Moscow and St. Petersburg define a no-cargo traffic zone within their city centres (the vehicles then need a special permission to drive in). More than 83% of public transport buses in Moscow comply with the Euro-4 or Euro-5 standard.

In January 2019, more stringent measures regarding low-carbon road transport entering Moscow were announced by the cities' government, supporting the corresponding initiative of the Presidential Council for Human Rights (Finmarket 2019). These measures include restrictions and possibly bans on entering certain zones for vehicles with engines of Euro-3, Euro-2, Euro-1 and Euro-0 classes. The share of such cars in Moscow accounted for 40 per cent, according to the Human Rights Council. In Russia overall, there were more than 58 per cent of these types of vehicles on Russia streets, according to the Autostat agency (2018).

A few cities (Moscow, St. Petersburg, Kazan, Yekaterinburg) develop bicycle and pedestrian infrastructure (including bicycle renting systems, bicycle lanes, parking lots for bicycles, widening pedestrian lanes, etc), and supporting car sharing schemes. Moscow has been a rather successful example of the car sharing scheme (12 operators, around 26000 cars, around 5 mln rentals in 2017, 36 mln rentals from January to September 2019 According to forecasts, the number of cars in Russian car-sharing services will increase by 3-4 times by 2023 and exceed 100 thousand cars (Moscow Department of Transportation, 2019,).

E-mobility has been rather slowly developing in Russia. As of July 2019, 4600 electric cars have been registered in Russia (more than 400 of them in Moscow) (Autostat, 2018). There are around 200 charging stations for electric cars in Moscow and Moscow region, 40 of them are run by the city (around 1000 all over Russia).

The Strategy of development of automobile industry in Russia till 2025 foresees the share of electric cars to come up to 1-1.5% (and 4-5% by 2024). According to a study by PricewaterhouseCoopers (PwC, 2019), an average annual growth rate of the Russian electric car market by 2025 could reach 30% (see also RBC 2019).

Since 2015 import tariffs for electric cars have been kept at 0% (electric lorries -- 5%), however due to the Customs Union regulation the tariffs were raised again to 17% (the pre-2015 levels) in the beginning of 2017. At the moment cancelling the import tariffs for electric cars is being discussed again on the federal level among a number of federal ministries.

Electric cars receive further benefits for parking in a number of Russian cities. They might also receive a right to use a bus/taxi lane in a number of cities, this issue is also being currently discussed. In three regions of Russia (Moscow region, St. Petersburg and Kaluga region) owners of electric cars are exempt from paying a transport tax. The owners of electric cars also get tax relief from luxury tax (e.g. any car costing more than 3 mln roubles). In Moscow and St. Petersburg parking is free for electric cars and there are certain parking lots reserved for e-vehicles. Most of communal (state-run) charging stations are also free.

In 2016 a federal government order was adopted which set up targets for gasification of transport sector (dependent on the city/area/region etc) by 2020 including the creation of urban infrastructure for natural gas vehicles. However, no further legislation in support of this order has appeared up till now.

There are a number of regional strategies for gasification of public (Moscow, St. Petersburg, etc) and private transportation. However, both gas vehicles and electric vehicles still occupy a very small share of the transportation.

Following the forest fires of 2010 and subsequent smog around Moscow a strategy of restoration of peatlands in Central Russia (including those around Moscow) has been adopted, and a subsequent program (together with the Succow Stiftung and the Wetland International) has been carried out (Succow Stiftung n.d.).

Responsibilities

The main actor is the field of air pollution in Russia on the federal level is the Ministry of Natural Resources and Environment (including the Rosprirodnadzor, Federal Service for Supervision in the Field of Natural Resources Use, a federal executive body of Russia under the jurisdiction of the Ministry of Natural Resources and Ecology of the Russian Federation). Further functions (especially in the area of transport regulation and energy generation) fall under the Ministries of Transport and the Ministry of Energy. The upper and lower chamber of the Russian Parliament also deal with the issue from time to time.

Regional ministries, commissions and departments are responsible for local measures, including developing bicycle/car-sharing/pedestrian/e-mobility infrastructure. The local governments are also responsible for dealing with waste managements (including landfills, more on that in 5.7) and spatial planning.

11.2 Climate change

Policy formulation and implementation

Under its national target, Russian Federation plans to reduce greenhouse gas emissions by 2020 by 25% below the 1990 levels, and by 25–30% by 2030 (Fedorov 2017). In March 2020, the Russian government has published a draft on its long-term strategy, based on projections of future emissions until 2050: In the first scenario, it projects an emission reduction of around 36 percent compared to 1990 levels; in the second scenario, it expects a decrease of around 48 percent (CAT 2020). These targets are also part of the Paris Agreement as Russia's pledge. "Limiting anthropogenic greenhouse gases (GHG) in Russia to 70-75% of 1990 levels by the year 2030 might be a long-term indicator, subject to the maximum possible account of absorbing capacity of forests" (INDC Russia, 2015). Current emissions emission reduction is not expected to reach the 2030 goals (CAT 2020).). In September 2019 Russia joined the Paris Agreement (through signing a governmental decree). As of January 2020, the country has not submitted its new pledges.

The main document outlining Russia's climate change strategy is the Climate Doctrine, adopted in 2009 under President Dmitry Medvedev. A 2020 action plan for this doctrine was signed in 2011; annual reports are presented by the Ministry of Natural Resources and Environment. Supporting plans include the 2020 Water Strategy of the Russian Federation (adopted in 2009, government decree no. 1235), the 2020 Forestry Development Strategy (adopted in 2008, ministerial decrees no. 248 and 482), the Food Security Doctrine (adopted in 2010, presidential decree no. 120), the 2025 Environmental Security Strategy (adopted in 2017, presidential decree no. 176) and other documents. Climate change is also factored into the Concept for Long-Term Socioeconomic Development of the Russian Federation up to 2020 (adopted in 2008, government decree no. 1662) and the 2030 Long-Term Socioeconomic Development Forecast.

A plan for the implementation of improved government regulations regarding GHG emissions as well as for the preparation of ratification of the Paris Agreement, prescribes climate regulation and legislation for the period up until the end of the year 2020 (Government of the Russian Federation 2016). In January 2020 a National action plan for the first phase of adaptation to climate change until 2022 has been adopted (Government of the Russian Federation 2020). The long-term low-carbon development strategy (until 2050) and a law introducing carbon reporting, verification and a possible model and measures for carbon regulation (including an introduction of a possible price on carbon) are currently being reviewed.

A 2009 law on energy efficiency stipulates that Russia's GDP energy intensity must decrease by 40% by 2020 relative to 2007 (Makarov 2014). A supporting government 2020 action plan for energy saving and energy efficiency was adopted in 2010 (government decree no. 2446). Yet there are concerns whether this target will be achieved, as GDP energy intensity dropped only by 10.9% in 2016 (BigPowerNews 2017). Broader estimates suggest a decline of 45% in energy intensity only by 2045 and relative to 2010 (INEI 2014). According to the Annual State Report on the Conservation and Efficiency of Energy Consumption in the Russian Federation (2019), the energy intensity of GDP has decreased by only 9% for over the past decade. Between 2007 and 2018, the energy intensity of GDP decreased by a total amount of 12%, although the 2008 presidential decree required a reduction of at least 40% by 2020. The annual percentage of reduction in energy intensity of GDP was 1.1 per cent between 2007 and 2018. The 40 per cent target that was set for 2020, will therefore only be reached by 2043. 0.2 per cent of Russian investments were directed towards these reduction targets. The share of private investments, however, decreases. The volume of investments in projects of energy savings accounts for 44 billion roubles, which is equal to around 0.5 per cent of total energy costs. Moreover, only 61 per cent of apartment buildings were equipped with consumption meters since 2012, only 27 per cent of tower blocks are considered to be energy efficient; and among the latter only 5 per cent have individual heat points with weather regulation (Kommersant 2020).

The government's renewable energy target has solar and wind power stations supplying 2.5% of total energy generation capacity in 2024. An increase to 5% by 2035 would require favourable circumstances and bolstering demand (IRENA 2017). While little institutional support is given to renewable energy sources, their importance is often stressed for areas with decentralized energy supply, which amount to 2/3 of the country's territory (Roshydromet 2011). Compared to 2017, the generation of energy by the solar power plants of the Unified Energy System of Russia was increased by 34.5 per cent in 2018, generating a total amount of 758.4 million kWh of electricity. From the beginning of 2019 onwards, the solar power plants under Russia's Unified Energy System reached an installed capacity of 834.5 MW, which equals approximately 0.3 per cent of total power plant capacity in Russia. Wind farms in turn generated 134.36 MW, which equals approximately 0.6 per cent of total power capacity of Russia's energy plants (Unified Energy System 2018).

At this time, most short- and midterm regional development programs lack adaptation plans or include nothing but provisions for emergencies caused by extreme weather events (Kattsov et al 2017). Exceptions include Moscow, a C40 member city that has decreased its greenhouse gas emissions from 100 million tons in 2014 to 82 million tons CO2eq in 2016 (Plus One 2017). Moscow has reduced greenhouse gas emissions from 2014 to 2019 by 18% (Moscow Department of Environment and Nature Use 2019). A city-level adaptation strategy, prioritizing extreme weather events, temperature fluctuations and human health impacts, has also been developed (Gasho et al 2017). Saint Petersburg is another notable exception, as a city-level adaptation strategy has been developed by local authorities (Malinin et al 2016). Among others are Kaliningrad, Khanty-Mansiysk region, Arkhangelsk region and Yakutia, where adaptation plans are currently in development (Plus One 2017).

At the urban planning level, risk assessments and updates to building codes are necessary (Roshydromet 2011), and adaptation should become a priority in municipal development and management. Climate insurance schemes, especially for regions affected by extreme weather events, are needed to support these efforts (Roshydromet 2011). Pilot adaptation schemes for select regions and cities would help determine and address barriers to adaptation (Vasilyev 2017); these plans are to be developed before 2022 (Kattsov et al 2017).

Further amendments to construction rules and regulations in the urban zones especially vulnerable to negative effects of climate change (e.g. floods, storms, etc) have gradually been introduced over the last 2.5 years by the Ministry of Construction, Housing and Utilities. This process of reforms of the federal and regional construction norms and rules is still going on.

Responsibilities

The Russian Ministry of Natural Resources and Environment leads the development and implementation of climate action both in mitigation and adaptation, with analytical support from Roshydromet, its weather and climate service, and Rosleskhoz, the federal forest authority. The Ministry of Economic Development oversees mitigation strategies for the industry and provides assessments of economic impacts of these strategies.

Ministries involved in climate change policy and planning include, among others, the Ministry of Energy, the Ministry of Transport, the Ministry of Agriculture, the Ministry of Healthcare and the Ministry of Construction Industry, Housing and Utilities Sector. These ministries provide input for the relevant parts of national mitigation and adaptation planning and develop sectoral risk assessments and strategies.

Regional and city governments are in charge of their respective regional development programs and adaptation strategies. These are typically designed and implemented by local environment authorities.

11.3 Water pollution

Policy formulation and implementation

The need to tackle water pollution (mainly with regard to the wastewater treatment and water infrastructure modernisation) is often mentioned in federal and regional strategies (including the 2020 federal Water Strategy first adopted in 2009 and since then regularly updated and amended).

The national project “Ecology” (see above) also includes several sub-programs with respect to reducing water pollution. “Clean Water” is one of them and addresses the improvement of quality of drinking water through the modernization of water supply and water treatment systems. Another sub-program is "Improvement of the Volga". It has the aim of a three-fold

reduction in the share of polluted wastewater discharged into the Volga River. Another sub-program of “Ecology” is the "Preservation of Lake Baikal" having a number of targets, including the construction and modernization of treatment facilities, the conservation and reproduction of biological resources, and the development of an environmental monitoring system. Finally, the sub-program "Preservation of unique water bodies" encourages the restoration and environmental rehabilitation of water bodies, the improvement of the ecological status of lakes and reservoirs, debris removal of coasts and adjacent lakes and rivers, as well as the improvement of the environmental conditions of the nearby population.

Most of the actions however are carried out at the regional/city level in form of public-private investment into water utility companies. Municipal water companies are also included into the list of companies which will have to start implementing the BAT legislation starting from early 2019.

Responsibilities

The Ministry for Natural Resources and Environment (including a special Federal Agency on Water Resources within the Ministry) is a main federal authority on water issues. Ministry of Health regulates drinking water standards, while the Russian Federal Consumer Rights Protection and Human Health Control Service monitors drinking water quality.

Regional authorities and regional or municipal (often city-owned and run) utility companies control water purification, preparation and its delivery to the houses, while also treatment of wastewater.

11.4 Noise pollution

Policy formulation and implementation

Noise pollution is mentioned as one of the pollution sources in the federal Law “On the atmospheric air protection” (1999, further amendments till 2015). Still, no comprehensive and coherent regulation of the problem is currently in place. All across the country there are standards for the safe level of noises (dependant on the area and its use), however, there are no measures tackling the noise or further policy instruments aiming to bring it down on the federal level.

In 2007 a Concept for noise pollution reduction in Moscow have been adopted, which, among others, set priorities to bring noise pollution down, thus improving wellbeing of the city residents, to develop acoustically favourable areas of the city, providing good conditions for the city residents to rest at night, etc. Since 2010 the Institute of the General Plan of Moscow has been mapping city districts and particular houses located in high noise pollution zones. As a result more than 25 km of noise protection barriers and screens have been constructed.

Central Moscow within the Moscow ring road is a no-flight zone (with a few exceptions, including military flights). Night flights are still allowed elsewhere (outside of the ring). Construction works are also allowed at night (with a few limitations for the noise level, however, they are not being regularly observed and controlled).

In May 2018 the Environmental Committee of the Civil Chamber of Russia has called up for further measures on limitation of noise pollution to be introduced in the largest cities of Russia, including further legislation reforms of construction rules, creating maps of noise pollution of the largest cities in the country and further measures to reduce noise pollution.

Responsibilities

The Ministry for Natural Resource and Environment, Ministry for Construction, regional city authorities (in Moscow – Mosecomonitoring Service within the Department of Nature use and Environmental Protection of the Moscow city government) are main authorities on noise pollution issues.

11.5 Urban green space and spatial planning

Policy formulation and implementation

Current urban policies in terms of urban planning and green urban infrastructure are determined by the priorities of national development stipulated in the recent Presidential decree, with key goals and indicators to be achieved by 2024. Some experts highly appreciate the concern for the quality (including the environmental aspect) of urban territories that is reflected in the decree, but at the same time note that the increase of construction of new housing up to 140 Mln. square meters per year that is set as one of key goals, can hardly be achieved without considerable environmental problems, if this intensification is implemented within the old paradigm of urban planning. Within the framework of this urban development initiative, nation-wide expert organizations (such as Strelka) have developed new standards, indicators and rules of quality of urban environment, which, despite their unifying value, also arouse controversy because of the “top-down” approach to their implementation.

For each specific city and town, however, the final layout of urban zones with different parameters of authorized construction and land use is determined during the adoption of urban development plans. These documents, usually adopted for 5 to 10 years period, are being developed by urban planning companies or institutes on the command of local administrations and adopted by local councils and on public hearings. They also usually reflect the balance of power between the three major stakeholders: local business, administration and communities of citizens.

Responsibilities

The list of goals, rules, indicators and standards of urban planning strategy, including the urban green infrastructure policy, is determined on the federal level by Presidential decrees (in terms of goals and indicators) and the extensive body of urban planning legislation and standards. Thus, ensuring meeting the goals and compliance with urban legislation on the nation-wide level is the responsibility of the government, especially of the Ministry of Construction which also oversees the financing of specific projects aimed at improving the quality of urban environment in different regions. However, the exact implementation of this urban development strategy at local and regional level, which usually reflects the balance of power between different stakeholders, is considered as responsibility of regional and local administrations in charge of development and implementation of urban spatial development plans and regulations. The implementation of these plans is supervised by local urban planning commissions and ensured by law enforcement institutions.

11.6 Waste generation and management

Policy formulation and implementation

The baseline legislation for the waste management in Russia is a federal law "On waste of production and consumption" (1998). All further legislation comes mainly in form of amendments to this basic law. The most important amendments were adopted in 2014, they prescribed an hierarchy of waste management (first reducing the waste, then recycling, then incineration, then placing waste at landfills), introduced an institute of Extended producer

responsibility, and also introduced regional operators (structures responsible for waste management in a particular region), while at the same time demanding that regional authorities need to work out their territorial schemes of waste management, and, finally, they also introduces licensing of waste management activities (of various kinds of hazard).

In December 2017 further amendments to the law have been approved. They demand that all territorial waste management schemes need to go through public hearings, and also that environmental fees (due to be paid as part of the extended producer responsibility) has to be investment into recycling facilities.

Further legislation in 2015-2019 has approved a list of good and products which had to be utilised on an obligatory basis (either by the producer or by paying an environmental fee), a list of production and consumption waste prohibited for burying at landfills (those containing valuable components), also a strategy for development of recycling and management of waste resulting from production and consumption till 2030. Further national and regional legislation coordinating the work of regional waste operators was adopted in 2019. In late 2019 a declared waste incineration one of the ways to utilize waste, which was heavily criticized by environmentalists (Government of Russian Federation 2019; Greenpeace 2019).

Responsibilities

Three national-level ministries are responsible for the waste management in Russia: The Ministry for Natural Resources, the Ministry for Construction and Communal and the Ministry of Industry and Trade.

The control bodies for the sector are a Federal Service for supervision of natural resources usage, Federal Service for Supervision of Consumer Rights Protection and Human Welfare, the State Prosecutor's office.

For a coordinating role of all these administrative bodies, a special governmental commission dealing with the waste of production and consumption was created.

Further waste management issues are within authorities of the regional governments. All regions are currently working out their territorial schemes and regional programs of waste management. It is expected that these documents should analyse the current state of affairs as well as to define priorities and strategies for the future. At the time of writing most regions are still working on their schemes and programs.

Additional regional legislation in the sector of waste management is also allowed (however is not very common). At the municipal level decisions are being made about waste collection points as well as about environmental education and awareness programs.

11.7 Summary

Russia has currently a number of national ministries and agencies dealing with urban environmental challenges, including the Ministry of Natural Resources, the Ministry for Economic Development, the Ministry for Construction, Housing and Utilities, the Ministry for Industry and Trade, the Ministry of Health, the Ministry of Transport and the Ministry of Energy.

Some of the urban environmental issues come under regional/city jurisdiction. Overall, regions vary greatly, also in their urban environmental challenges, their root cases, and financial and administrative resources to deal with the problems. Apart from Moscow (and partly St. Petersburg) most regions usually look up for financial help and incentives from the federal government in solving urban environmental challenges.

At the same time Russia is going through a number of reforms of environmental legislation, many of which also tackle urban environmental challenges. With environmental problems becoming ever more important in political and public discourse, as well with further urbanisation, city growing and wealth increasing processes taking place, these reforms are due to continue. Among the main obstacles hindering the process (at the legislation and also implementation level) are pressure from polluting companies (mainly of minerals/extraction/coal sectors), lack of public money invested into communal infrastructure), lobby and vested interests of powerful economic stakeholders in the sectors of urban construction, unwillingness of authorities to implement any unpopular measures (e.g. restrictions for car-users, etc). Many urban environmental challenges in Russia are being tackled on a short-term basis (as emergencies). Due to financial and economic interests on the one hand, and the lack of political willingness on the other hand, overall sustainable strategic city management (and planning) is hardly in place (it is only really emerging these days in Moscow).

Another challenge is poor coordination between various authorities (especially on the regional level), when environmental, transport, city development, infrastructure and housing, waste management, management of green zones in the city all come under various departments/ministries, so that there an overall holistic (sustainable) approach lacks. Also, just a limited number of cities have something like sustainable development plans (or climate plans/strategies, or low-carbon development strategies), which would then act as cross-sectoral documents integrated in various aspects of cities development and functioning. Even if these documents exist, they are often treated as unimportant or too abstract to be implemented or considered.

Governance of environmental protection

In order to mitigate the urban environmental challenges identified in Russia, a relatively broad range of actors appears as relevant.

On the national level, the Ministry of Natural Resources and Environment and its agencies (the Russian Federal Service for Hydrometeorology, the Federal Agency on Water Resources) is the central actor in the area of air and water pollution and climate change. On air quality Ministry of Transport and Ministry of Energy are another important actors (mainly in the area of development of sustainable mobility, reduction of air pollution from transport sector and also from coal/other fossil fuels generation).

In the issue of waste generation and management the Ministry of Natural Resources and Environment takes on a complementary role together with the Ministry of Construction and the Ministry of Industry and Trade. An issue of green zones and sustainable city developments often appears within regional (city) authorities, with general standards and requirements set and approved by the federal authorities (Ministry of Construction is among them). The Ministry of Health regulates drinking water standards and monitors drinking water quality.

On the regional (city) levels, decision-making is often dependant on the status of the city (e.g. whether it is a regional capital or a city of federal importance like Moscow or St. Petersburg), what are the main sources of regional budget incomes, whether there are any large polluting industries present in the city (or right next to it), etc. In general, decisions about future city planning, green zones, and also since recently, decisions about waste generation and management (including working out territorial schemes for waste management and choosing a regional operator for waste management) are also done on the regional level (through regional governments, departments, ministries etc). Some regions also become active in drafting their climate adaptation plans (see Climate change section for further information).

Based on the above sections, the following Table 13 summarizes the national policies that aim to tackle environmental challenges at the urban level, as well as their status and ambition. The priority assessment in the right-hand side column is an own assessment based on the criteria as outlined in the Methodology section.

Table 13: National policy implementation regarding urban environmental challenges in Russia

Challenge	Policies	Status and ambition	Priority
Air pollution	Introduction of the Best Available Technologies	Being currently implemented	High
	Emission vehicle standards	Euro 6 introduced, slow setting of ambitious standards compared to EU countries	
	2025 Environmental Security Strategy	An overarching document setting major priorities in the area of sustainable development and environmental protection	
	National Project "Ecology"	Being currently implemented	
	Ambient air standards	Implemented	
Climate change and its effects	National Climate Doctrine and a 2020 action plan	Implementation in progress; binding targets for 2020, however the role of the cities is not defined. However, ongoing gasification of energy generation in largest cities contributes to bringing emissions down also in the urban context	Medium
	National adaptation plan	Adopted, due to be followed by regional and sectoral plans	
	National Energy Efficiency Targets and accompanying policies (including a new energy efficiency stimulation package of measures approved in April, 2018)	Currently implemented, but results are somewhat unambitious so far	
	Renewable energy targets	Currently implemented; doesn't have a significant impact over urban areas	
	The Package of measures aimed at preparation for the ratification of the Paris Agreement (including a national low-carbon development strategy, an analysis of the socio-economic consequences of the ratification, creating a system of carbon monitoring, reporting and verification system, as well as a carbon regulation model, and also all	Currently implemented, falling behind schedule on most measures	

Challenge	Policies	Status and ambition	Priority
	further legislation connected with Russia's INDC for 2030)		
	Joining the Paris Agreement	The new climate target is awaited in 2020. Otherwise impact at urban areas is unclear at the moment.	
Noise pollution	Federal Policies or strategies unknown (some regional ones, say, in Moscow have been approved, but seem to be playing a rather unimportant role)		Low
Water pollution and availability	2020 Water strategy of the Russian Federation (2009)	Currently implemented and regularly updated and amended. Overall this is a very general document, providing more of a framework rather than a specific set of measures	High
	The introduction of the BAT (with regard to the regional and city water municipal companies)	Currently implemented, sources of financing not always clear (e.g. will certainly fall behind schedule)	
	National Project "Ecology"	Being implemented	
	State standards for drinking water	Implemented	
Urban green space and spatial planning	Land use and development rules (on federal and regional/city levels), rules of providing of public services and utilities (also federal/regional/city levels), planting/greening rules (federal/regional/city levels), city master plans and general plans (regional/city levels), all regularly updated and amended	Currently implemented	Medium
Waste generation and management	federal law "On waste of production and consumption" (1998) and further amendments to it (running till now)	Currently implemented	High

Source: Own compilation and own priority assessment based on literature analysis, Wuppertal Institute

12 Political priorities in India

This section describes overriding areas of national action. The formulation of key national policies to tackle these challenges are analysed with a view to understand their ambition and stringency.

12.1 Air pollution

Policy formulation and implementation

The Supreme Court of India asked the Ministry of Environment, Forests and Climate Change (MoEFCC) to notify a comprehensive action plan for all sources of air pollution in the major polluted city – Delhi and the National Capital Region (NCR - Haryana, Rajasthan and Uttar Pradesh). This is the first ever mandatory plan in India that earmarks short, medium- and long - term measures for all key sources of pollution with deadlines, and makes agencies responsible for implementation. According to this plan, Delhi-NCR needs to reduce particulate pollution by at least 74 % to meet clean air standards (CSE, 2018) (EPCA, 2017). Some of the sector-wise action plans to control or alleviate air pollution in India, mainly Delhi are shortly discussed below.

Control pollution from biomass burning

Although the Delhi government has tried to make the city kerosene- free and expanded the liquefied petroleum gas (LPG) coverage, a lot more will have to be done. The Indian government has initiated several schemes (restructure subsidies for clean fuel) to expand the distribution of LPG to make clean fuel available to the poor and make LPG affordable and accessible for them.

Control crop fires

Though crop fires are seasonal, they have a huge impact on Delhi's air pollution. To dissuade farmers from burning crop residues, the state governments (Punjab and Haryana) have notified crop burning as an offence and launched campaigns to make farmers aware about the consequences (Narain, et al., 2016), but the implementation has been minimal (Biswas, et al., 2017). There is a provision of governments subsidy for machines that mix straw with soil while tilling soil and drilling seeds (Narain, et al., 2016).

Stop garbage combustion

There is a legal ban on open waste burning, but it is not easy to enforce it. In 2016, the EPCA (Environment Pollution (Prevention and Control) Authority) had called upon the civic authorities to ensure stopping burning of horticulture waste in parks, and instead compost pits are used to dispose of dead leaves and branches. But the enforcement was poor. Private citizens can and are helping to segregating garbage and selling garbage that can be recycled and stop fires in neighbourhoods (Narain, et al., 2016). Swachh Bharat Urban mission have various projects and campaigns to control garbage combustion.

Control pollution from power plants and industries

Some actions such as the notice to close down the Badarpur Thermal Power Plant has been taken place. In Industries, a notice on an urgent ban on furnace oil, pet coke has been issue, which are dirty industrial fuels with Sulphur and heavy metals. Regarding brick industries, options to move to clean technology such as using zigzag technology are encouraged (EPCA, 2017). Zigzag technologies use less energy, reduce black carbon drastically and produce good quality bricks (Narain, et al., 2016). They are based on the idea that the air fluid during a firing process for the production of bricks is more efficient. The air path is longer, the air velocity is

larger and the turbulence in the kiln result in a more efficient heat transfer between the bricks and gases (Lalchandandi and Maithel 2013).

Transportation (clean vehicles and fuels, and improve and scale up public transport)

To reduce emission from the vehicles, the Union Ministry of Petroleum and Natural Gas had notified the introduction of Bharat Stage IV norms nation-wide from April 2017. Transport departments across the states need to take appropriate steps to ensure this. The Environment Pollution (Prevention and Control) Control Authority (EPCA), in its report to the Supreme Court, has also raise the issue to fix the environment tax on diesel cars in such a way that it helps equalise the fuel tax for both petrol and diesel cars. The Supreme Court gave directives not to allow any diesel taxi to operate in Delhi, but CNG taxi (Narain, et al., 2016).

Beside clean fuels, the Delhi Master Plan has set the target of achieving 80:20 modal share for public transport (e.g. CNG bus fleets) by 2020, which require massive expansion of the bus and Metro systems and non-motorised transport. Delhi also has already adopted people-friendly street-design guidelines and revised the Indian Road Congress (IRC) guidelines to address the needs of pedestrians and cyclists. The guidelines need to be made mandatory for the approval of road network projects in Delhi (Narain, et al., 2016).

Ban the use of diesel generator sets

In Delhi, the use of diesel generator sets are especially controlled for social events during the winter months as an emergency measure (Narain, et al., 2016)

Curtail road dust

To curtail road dust, the Delhi government has started the process of acquiring vacuum cleaning machines. As an emergency measures, water is sprinkled on roads and footpaths (Narain, et al., 2016).

On the construction site, the Supreme Court has also directed the Delhi government to undertake control measures for fugitive emissions from material handling, conveying and screening operations through water sprinkling, curtains, barriers and dust suppression units (EPCA, 2017).

Responsibilities

The national government of India, including the MoEFCC, is taking a major responsibility to formulate plans and actions to mitigate air pollution in India. The Central Pollution Control Board (CPCB) is a statutory organisation that provide technical service to MOEFCC and take actions to improve the quality of air and to prevent, control or abate air pollution in the country (CPCB, 2018). The Environment Pollution Prevention & Control Authority (EPCA), a supreme court-appointed environment watchdog for the National Capital Region, carries out activities to protect and improve the quality of the environment and prevent, control and abate environmental pollution. State and local governments in India create their own initiatives to minimise air pollution.

12.2 Climate change and its effects

Policy formulation and implementation

India ratified the Paris climate agreement in October 2016, after the submission of its Intended Nationally Determined Contributions (INDC). India's INDC include a broad scope of putting forward and propagating a healthy and sustainable way of living based on traditions and values of conservation and moderation. It aims at adopting a climate friendly and a cleaner path than

the one followed hitherto. India's target is to reduce the emissions intensity of its GDP by 33 to 35 % by 2030 compared to 2005 levels. The target will be reached through emphasis on renewable energy, promotion of clean energy, enhancing energy efficiency, climate resilient urban centres and sustainable green transportation networks. Moreover, India will also develop climate resilient infrastructure, implement policies/missions targeting various threats facing agriculture, protect coastal regions and islands from the impact of accelerated sea level rise and protect biodiversity and the Himalayan ecosystem – in order to adapt to climate change (Government of India, 2015).

Some of the key policies addressing climate change in India are:

National Action Plan on Climate Change (NAPCC)

The National Action Plan on Climate Change (NAPCC), launched in 2008 by the Indian government with missions or programs on wind energy, health, waste to energy, and coastal areas (running from 2017 to 2022), highlights India's most pressing climate concerns (TERI, 2015). The identified eight National Missions form the core of the plan, representing multi-pronged, long term, integrated strategies for achieving goals in the context of climate change and on priority adaptation and mitigation issues:

1. National Solar Mission (mitigation focus)
2. National Mission on Enhanced Energy Efficiency (mitigation focus)
3. National Mission on Sustainable Habitat (mitigation and adaptation focus)
4. National Mission on Strategic Knowledge Management (mitigation and adaptation focus)
5. National Mission for a Green India (mitigation and adaptation focus)
6. National Water Mission (adaptation focus)
7. National Mission on Sustainable Agriculture (adaptation focus)
8. National Mission on Sustainable Himalayan Eco-systems (adaptation focus)

State Action Plan on Climate Change (SAPCC)

The State Action Plan on Climate Change (SAPCC) in India is the most notable policy reflecting the decentralized climate change mitigation framework of the country. In 2009, the Government of India notified state governments to come up with their own climate change mitigation and adaptation policies, plans and actions aligned with their respective state priorities and the NAPCC goals. The states are required to seek prior approval from the MoEFCC before implementing the activities listed therein. Until October 2014, 30 states (including Union Territories) have completed the draft plan; the ministry has endorsed 19 plans and the Expert Committee on Climate Change has considered three (TERI, 2015).

Smart Cities Mission

Smart Cities Mission aim an area-based development in Indian cities by the city improvement (retrofitting), city renewal (redevelopment) and city extension (greenfield development) plus a Pan-city initiative in which Smart Solutions are applied covering larger parts of the city (MoHUA, 2017). It was initiated by the Ministry of Housing and Urban Affairs, Government of India in 2015 in collaboration with the state governments of the respective cities. Its features include promoting mixed land use in area based developments, housing and inclusiveness, creating walkable localities, preserving and developing open spaces, promoting sustainable transport options, making government measures citizen-friendly and cost effective, supporting local social and economic activity, and applying smart solutions to infrastructure and services. As of January 2018, 99 proposals/cities have been selected as a part of Smart Cities Mission.

National Urban Transport Policy (NUTP) 2014

The National Urban Transport Policy (NUTP) 2014, issued by the Ministry of Urban Development (MoUD) (now MoHUA), incorporates a plan for the people rather than vehicles by providing sustainable mobility and accessibility to all citizens to jobs, education, social services and recreation at affordable cost and within reasonable time. It supports a paradigm shift to urban transportation with three key strategies 'avoid, shift and improve' in transport planning (MoUD, 2014).

India also has other policies to support sustainable transportation, such as the National Metro Policy (2017), and the National Transit Oriented Development (TOD) Policy (2017); and to enhance energy efficiency (such as Energy Conservation Act 2001).

Responsibilities

The national government of India, such as MoHUA and MoEFCC, are taking a major responsibility to formulate plans and actions to mitigate and adapt to climate change in India. In terms of National Missions, they are institutionalized by respective ministries and are organized through inter-sectoral groups that include, in addition to related Ministries, the Ministry of Finance and the Planning Commission, as well as experts from industry, academia and civil society (LSE, 2008). For example, the Ministry of New and Renewable Energy (MNRE) is taking actions to realise National Solar Mission's target of deploying 20,000MW of grid connected solar power by 2022. Likewise, implementation agencies for the National Mission for Enhanced Energy Efficiency are the Bureau of Energy Efficiency (BEE) under the Ministry of Power and the Energy Efficiency Services Limited (EESL) – a joint venture of the National Public Sector Enterprises set up under the Ministry of Power.

NITI Aayog, a policy 'Think Tank' of the Indian government also provides directional and policy input, and technical advice to the Centre and states (NITI Aayog, 2017). State governments in India create their own initiatives for climate action. On the municipal level, regional integrated planning is carried out.

12.3 Water pollution and availability

Policy formulation and implementation

The Indian Constitution has included the 'right to get pollution free water and air' (Article 21) considering the right to quality of life (Drishti, 2015). The Water (Prevention and Control of Pollution) Act has been enacted in 1974 by the Ministry of Environment, Forest and Climate Change, that mandates to maintain water quality and restore the wholesomeness of national aquatic resources by preventing pollution (Lahiry, 2017). However, this act is not stringent on groundwater management policies. The Water Prevention and Control of Pollution Cess Act (2003), under the Ministry of Law and Justice, controls disposal of industrial waste polluting rivers in India (Ministry of Law and Justice, 2003). The National Water Policy (2012), under the Ministry of Water Resources, made several recommendations for conservation, development and improved water resource management in the country (Lahiry, 2017).

Responsibilities

Most of the water planning and development in India is done per administrative boundaries rather than by using river basins as the hydrological unit (also river basin management plans and active river basin authorities are absent). This can sometimes arise and intensify water conflict issues as most river basins are shared by several states and water demand to meet domestic, industrial and agricultural needs. Under the Indian Constitution, the state is responsible for water related issues but the centre can resolve conflicts over the use of inter-state rivers (Lahiry, 2017). State government develops water infrastructure according to the

need. In 2001, Tamil Nadu government made obligation to have rainwater harvesting infrastructure to improve overall water quality. However, to increase compliance, local people need to be aware of the system and save water for usage (Dutta, 2017). As water scarcity is a major issue in many states or cities in India, states/cities need to be responsible to improve water use efficiency, reduce leakages, adoption of appropriate water tariff, rehabilitate and recharge local water bodies (Lahiry, 2017).

The Ministry of Drinking Water and Sanitation has developed the National Rural Drinking Water Programme (NRDWP) to improve water infrastructure and capacities for the successful operation of drinking water supply schemes in rural areas (MDWS, 2018).

12.4 Noise pollution

Policy formulation and implementation

India has developed different laws related to control noise pollution, such as the Noise Pollution (Regulation and Control) Rule from 2000 under Environment Protection Act 1996, last amended in January 2010 to reduce noise levels at night and from public address systems (livemint, 2016). The Government of India has taken various actions to control noise pollution. The Central Pollution Control Board (CPCW) established the noise pollution monitoring network in 2011 in 35 major cities in India including metro cities such as Delhi, Hyderabad, Kolkata, Mumbai, Lucknow, Bangalore and Chennai. The CPCW in association with the State Pollution Control Boards monitors and analyses the ambient noise levels and disseminates the noise information to the public (Evaluation and Analysis of Environmental Noise Pollution in Seven Major Cities of India, 2017).

Responsibilities

To control the noise generation by various sources in the environment, the Central Pollution Control Board, under the Ministry of Environment and Forests, has set sound standards for different categories of areas (residential, commercial, industrial and silence zones). It has set vehicular permissible noise limits at the manufacturing stage and noise standards for firecrackers (Community Noise Pollution in Urban India: Need for Public Health Action, 2014). Although the urban development authority of every Indian city has a master plan to separate and segregate noise polluting areas (such as noisy and polluting industries from residential areas), there is an increase in noise pollution. A stronger community action is required to insist the authorities to follow the master plan. While motor vehicles with jarring sounds for horns and damaged exhaust pipes are banned, they are still popular in Indian cities. Therefore, on a national level, a strict enforcement of laws for noise control is necessary (Chandrasekar, n.d.). Moreover, awareness of the public and stakeholders is required in the prevention and control of community noise pollution in Indian cities (Community Noise Pollution in Urban India: Need for Public Health Action, 2014). The state government, along with the support and cooperation of NGOs, can organize awareness programmes (Miglani, 2015) (e.g. Awaaz foundation).

12.5 Land sealing and loss of green and open spaces

Policy formulation and implementation

India has the National Forest Policy that aims to ensure that a minimum of one-third of the total land area of the country remains under a forest or tree cover. It encourages to plant trees alongside roads, railway lines, rivers, streams, and canals. India has developed the National Mission for Green India under the National Action Plan for Climate Change (Urbanisation and greening of Indian cities: Problems, practices, and policies, 2016). Voluntary standards such as

the Green Rating for Integrated Habitat Assessment (GRIHA) guide sustainable built environment considering relationship between buildings and surrounding environment. Policies supporting the implementation of green infrastructure and green roofs are also available in India. However, compliance and enforcement of buildings and infrastructure is not strong in many cities in India.

Responsibilities

State governments, city governments and urban planning agencies in India are responsible to provide tools, guidelines and information about the impact of buildings, infrastructure and urbanisation on the urban climate (TERI, 2017).

12.6 Waste generation and management

Policy formulation and implementation

The Ministry of Environment, Forests and Climate Change of India has published several rules for waste management (MoEFCC, 2018), such as:

- Plastic Waste Management Rules 2016 (Amendment in 2018)
- Bio-Medical Waste Management Rules 2016
- Solid Waste Management Rules 2016
- Construction and Demolition Waste Management Rules 2016
- E-Waste (Management) Rules (Amendment in 2018)

These rules designate municipal authorities as the legal entities to manage waste in their jurisdictions. Municipal authorities take responsibility for implementing these rules and developing infrastructure for collection, storage, segregation, transportation, processing and disposal of municipal solid waste (MSW) (Kumar, et al., 2017). However, the regulatory framework for the waste management sector does not include necessary clauses for effective implications, such as financial implications for non-compliance of the rules by a ULB (ASSOCHAM, 2017).

With the support of the Solid Waste Management Rules, of MoEFCC, the Ministry of Urban Development (MoUD) also formulated a Sustainable Municipal Solid Waste Management (MSWM) Manual (2016). It guides all urban areas in the country towards MSWM, adopting the aspects to minimize waste at source with an emphasis on the 3R principles of reduce, reuse and recycle; with proper systems of segregation, collection, transportation, processing, treatment and disposal in complete harmony with the environment, thereby leading to the achievement of the aim of the National Urban Sanitation Policy and Swachh Bharat (clean India) Mission (Government of India, 2016). Another national level initiative to improve waste management in India is the Smart Cities mission (under which 100 cities will be provided with significant funding to improve civic services infrastructure) and the Atal Mission for Rejuvenation and Urban Transformation (AMRUT). State governments also provide financial support to ULBs to improve their waste management systems through various schemes and programs (Yedla, 2016).

Responsibilities

Waste management is a pressing issue in India. On a national level, the Government of India initiated flagship programmes such as the Smart City Mission and the Swachh Bharat Mission. According to the Indian Constitution, the responsibility for solid waste management is under the

state government and the urban local bodies (ULBs). As mentioned in the Municipal Solid Waste Management and Handling Rules, 2016, ULBs are responsible to manage solid waste in their area and infrastructure development for collection, storage, segregation, transportation, processing and disposal of municipal solid wastes (ASSOCHAM, 2017). Besides that, the informal sector also plays a major role in waste management – to collect and segregate wastes, resulting in less waste reaching landfills (Lahiry, 2017). Local initiatives by small companies, such as the biogas production from biological and organic waste in Pune (Ahluwalia , 2016) and recycling plastics in Mumbai (Seetharaman, 2017), help managing waste in the cities.

12.7 Summary

Political system

India, considered as the world's largest democracy, follows a tripartite governance model of 'cooperative federalism', in which administrative responsibilities and environmental policies are divided between the Centre (national), State and Local (city) governments. However, the main responsibility of climate policy and multilateral negotiations belongs with the Central Government. Although, the individual states are responsible to implement climate policy, India is still a relatively centralised federal country and the states still rely tremendously on the Central Government, both politically and financially (Jörgensen, et al., 2017). Moreover, in the absence of publicly-elected mayors in some cities, policymaking and funding for local governments are controlled by the states (Mathew, et al., 2017) (Chaudhary, 2018)

Governance of environmental protection

The key responsibilities of the national, state and municipal level in India are summarised in this section.

National level

More than 50 national ministries exist in India. At the national level, three key nodal ministries are responsible for environmental protection and urban development. They include-
1) The Ministry of Environment Forest and Climate Change (MoEFCC)
2) The Ministry of Housing and Urban Affairs (MoHUA)
3) The Ministry of New and Renewable Energy (MNRE)

Ministry of Environment Forest and Climate Change (MoEFCC)

The MoEFCC's main objective is to implement policies and programmes relating to the conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution – for the sustainable development and enhancement of human well-being (MoEFCC, 2015). These objectives are well supported by a set of legislative and regulatory measures which aim to preserve, conserve and protect the environment. Policies such as the National Conservation Strategy and Policy Statement on Environment and Development (1992), National Forest Policy (1988), Policy Statement on Abatement of Pollution (1992); and the National Environment Policy (2006) also guide the Ministry's work (MoEFCC, 2015). The Central Pollution Control Board (CPCB) is a statutory organisation that provide technical service to the MoEFCC and take actions to improve the quality of air and to prevent, control or abate air pollution in the country.

Ministry of Housing and Urban Affairs (MoHUA)

The MoHUA was formed in 2017 after merging two former ministries – the Ministry of Urban Development and the Ministry of Housing & Urban Poverty Alleviation (MoHUA, 2017). This

ministry supports state and local governments on activities such as all government civil works and buildings, planning and coordination of urban transport system, water supply (subject to overall national perspective of water planning and coordination assigned to the Ministry of Water Resources, River Development and Ganga Rejuvenation), all matters relating to the Housing and Urban Development Corporation (HUDCO) and formulation of housing policy and programme (MoHUA, 2017). Some of the schemes / programmes run by the MoHUA for urban development are - Smart cities Missions, AMRUT, Swachh Bharat Mission, HRIDAY and National Urban Transport Policy (NUTP).

Ministry of New and Renewable Energy (MNRE)

The MNRE is the nodal Ministry at the federal level to develop and deploy new and renewable energy for supplementing the energy requirements of the country. The ministry's mission is to ensure energy security (lessen dependence on oil imports), increase the share of clean power (wind, hydro, solar, geothermal etc.), energy availability and access (supplement energy needs of cooking, heating, lighting etc in rural, urban, industrial and commercial sectors), energy affordability (cost-competitive, convenient, safe and reliable) and energy equity (MNRE, 2018).

Other important ministries which support the energy, transport and urban development are:

Ministry of Power

The Ministry of Power is mainly responsible for the development of electrical energy in the country. The Ministry is concerned with planning, policy formulation, procurement, monitoring of the implementation of power projects, training and capacity development and the administration and enactment of legislation with regards to thermal, hydro power generation, transmission and distribution. The Ministry of Power is responsible for the Administration of the Electricity Act, 2003, the Energy Conservation Act, 2001. The goal of the Energy Conservation Act (EC Act) was to reduce energy intensity of Indian economy. The Bureau of Energy Efficiency (BEE), a statutory body under the Ministry of Power, is responsible to spearhead the improvement of energy efficiency in the economy through various regulatory and promotional instruments (MoP, 2018).

Ministry of Road Transport and Highways

The Ministry of Road Transport and Highways carries out the task of formulating and administering, in consultation with other Central Ministries/Departments, State Governments/UT Administrations, organisations and individuals, policies for road transport, national highways and transport research with a view to increasing the mobility and efficiency of the road transport system in the country. The Ministry has two wings: Roads wing and transport wing (MoRTH, 2018).

Ministry of Drinking Water and Sanitation

The Ministry of Drinking Water and Sanitation has developed the National Rural Drinking Water Programme (NRDWP) to improve the water infrastructure and capacities for the successful operation of drinking water supply schemes.

State and Municipal level

In order to regulate the state governments of India, ministries have further line departments, regulatory committees and executive divisions, such transport department, power departments and a department for environment and climate change (Chaudhary, 2018). As stated earlier, the Government of India notifies state governments to formulate plans, policies and take actions, such as to prevent and control pollution through the State Pollution Control Board, which further co-ordinates with local governments. State and local government in India create their

own initiatives to take actions. For example, the Delhi Electricity Regulatory Commission issued Net Metering for Renewable Energy Regulations in 2014 to promote renewable energy generation. According to the Indian constitution, for water related issues, the state governments are responsible to develop water infrastructure according to the need. State governments and municipal governments are actively involved in nationally initiated missions such as Smart Cities Mission. Urban development authorities, in connection with municipal corporations, develop city master plans, infrastructure, land development, transport systems and building construction projects. In terms of solid waste management, state governments and municipal or urban local bodies are responsible to manage solid waste in their areas and infrastructure development.

Figure 8: Indian authorities in the field or urban environmental protection

Source: Own illustration, Wuppertal Institute

Based on the above sections, the following Table 14 summarizes the national policies that aim to tackle environmental challenges at the urban level, as well as their status and ambition. The priority assessment in the right-hand side column is an own assessment based on the criteria as outlined in the Methodology section.

Table 14: National policy implementation regarding urban environmental challenges in India

Challenge	Policies	Status and ambition	Priority
Air pollution	Comprehensive action plan by the MoEFCC	A mandatory plan in India for all sources of air pollution in the major polluted city – Delhi and the National Capital Region (NCR - Haryana, Rajasthan and Uttar Pradesh). It earmarks short, medium and long term measures for all key sources of pollution with deadlines, and makes agencies responsible for implementation.	Medium

Challenge	Policies	Status and ambition	Priority
	Schemes to control pollution from biomass burning	The Indian government has initiated several schemes (restructure subsidies for clean fuel) to expand the distribution of LPG to make clean fuel available to the poor and make LPG affordable and accessible for them.	
	Campaign to control crop fires	To dissuade farmers from burning crop residues, the state governments (Punjab and Haryana) have notified crop burning as an offence and launched campaigns to make farmers aware about the consequences	
	Swachh Bharat Urban mission	various projects and campaigns to control garbage combustion. Enforcement of a legal ban on open waste burning was poor	
	Control pollution from power plants and industries	Some actions such as notice to close down the Badarpur Thermal Power Plant has been taken place	
	introduction of Bharat Stage IV norms nation-wide from April 2017	To reduce emission from vehicles. Transport departments across the states need to take appropriate steps to ensure this.	
	environment tax on diesel cars	Raised by the Environment Pollution (Prevention and Control) Control Authority (EPCA) in a report to the supreme court.	
	Delhi Master plan to set the target of achieving 80:20 modal share for public transport (e.g. CNG bus fleets) by 2020	Not implemented; require massive expansion of the bus and Metro systems and non-motorised transport	
Climate change and its effects	INDC target to reduce the emissions intensity of its GDP by 33 to 35 % by 2030 compared to 2005 levels	Ongoing; The target will be reached through emphasis on renewable energy, promotion of clean energy, enhancing energy efficiency, climate resilient urban centres and sustainable green transportation networks.	High
	National Action Plan on Climate Change (NAPCC)	launched in 2008 by Indian government with missions or programs on wind energy, health, waste to energy, and coastal areas (running through 2017 to 2022)	

Challenge	Policies	Status and ambition	Priority
	State Action Plan on Climate Change (SAPCC)	Ongoing; State governments come up with their own climate change mitigation and adaptation policies, plans and actions aligned with their respective state priorities and the NAPCC goals.	
	Smart Cities Mission	an area-based development in Indian cities by the city improvement (retrofitting), city renewal (redevelopment) and city extension (greenfield development) plus a Pan-city initiative in which Smart Solutions are applied covering larger parts of the city	
	National Urban Transport Policy (NUTP)	plan for the people rather than vehicles by providing sustainable mobility and accessibility to all citizens to jobs, education, social services and recreation at affordable cost and within reasonable time	
Noise pollution	constitution of India stating Right to Life (Article 21), Right to Information, Right to Religion and Noise.	Support the control of air pollution	Medium to low
	Noise Pollution (Regulation and Control) Rule 2000 under Environment Protection Act 1996	to reduce noise levels at night and from public address systems	
	noise pollution monitoring network by Central Pollution Control Board (CPCW)	noise pollution monitoring network in 2011 in 35 major cities in India including metro cities	
Water pollution and availability	Constitution of India stating 'right to get pollution free water and air'	(Article 21) considering right to live quality of life	Medium
	Water (Prevention and Control of Pollution) Act	Maintain water quality and restore the wholesomeness of national aquatic resources by preventing pollution	
	Water Prevention and Control of Pollution Cess Act	Controls disposal of industrial waste polluting rivers in India	
	National Water Policy (2012)	Recommend conservation, development and improved water resource management in the country	
Land sealing and	National Forest Policy	Aims to ensure that a minimum of	Low

Challenge	Policies	Status and ambition	Priority
loss of green and open spaces		one-third of the total land area of the country remains under forest or tree cover	
	Green Rating for Integrated Habitat Assessment (GRIHA)	Guide sustainable built environment considering relationship between buildings and surrounding environment	
Waste generation and management	Solid Waste Management Rules by MoEFCC	Municipal authorities take responsibility for implementing these rules and developing infrastructure for collection, storage, segregation, transportation, processing and disposal of municipal solid waste	Medium to low
	Sustainable Municipal Solid Waste Management (MSWM) Manual	guides all urban areas in the country towards MSWM, adopting the aspects to minimize waste at source	

Source: Own compilation and own priority assessment based on literature analysis, Wuppertal Institute

13 Political priorities in China

This section describes overriding areas of national action. The formulation of key national policies to tackle these challenges are analysed with a view to understand their ambition and stringency.

13.1 Air pollution

Policy formulation and implementation

In 2013, the State Council issued the Air Pollution Prevention and Control Action Plan, which specifies a set of targets for air quality by 2017. The plan pledges to 1) reduce annual average PM2.5 concentration in three key metropolitan regions (Beijing-Tianjin-Hebei region, the Yangtze River Delta, and Pearl River Delta by 25%, 15%, and 10%, respectively); 2) reduce the concentration of PM10 by 10% in all cities; 3) reduce PM2.5 levels from 89.5 μg/m^3 in 2013 to 60 μg/m^3 in Beijing (Central People's Government of the P.R.C 2013). Except for sectoral measures, the Action Plan also clearly links air quality improvement to local officials' (de)promotion and encourages regional and cross-departmental collaboration. Given the challenges of air quality improvement in the most severely polluted Beijing-Tianjin-Hebei region, in 2016, the Ministry of Environmental Protection, Beijing, Tianjin and Hebei governments jointly issued an action plan for the region. This plan includes a set of measures to be implemented in 2016 and 2017, such as closure of polluting factories on the peri-urban areas, replacing coal stoves used in the surrounding areas, upgrading, replacing, or limiting polluting vehicles (Ministry of Ecology and Environment of P.R.C 2016).

Responsibilities

Since air pollution is a cross-sectoral issue, different ministries and their line offices at the local levels are involved. Given the severity of the issue and strong political will of reducing air pollution, the State Council, who executes laws and supervises the government bureaucracy and carries out the administrative functions of the central government, issued the Air Pollution Prevention and Control Action Plan. The Ministry of Environment (MEP) coordinates various actions of air pollution reduction, sets the standards, and monitors the implementation. Besides, the National Development and Reform Commission (NDRC) who formulates policies for economic and social development, the Ministry of Industry and Information Technology, the Ministry of Finance, the Ministry of Housing and Urban-Rural Development (MOHURD), the Ministry of Transport, the Administration of Energy, and Meteorological Administration are actively involved.

13.2 Climate change and its effects

Policy formulation and implementation

In 2015, China submitted UN its „Enhanced actions on climate change", in which China committed to reducing its carbon intensity by 60-65% from 2005 levels by 2030, peaking its carbon emissions by 2030, increasing non-fossil-fuel energy to 20 % of its energy mix, and expanding forested land.

This commitment is supported by the 13th Five- Year Plan (2016 to 2020). It targets at a 15% energy intensity reduction and an 18% carbon intensity reduction by 2020, compared to 2015 level. Experts estimate that this target will enable China to exceed its original targets set in Copenhagen (Henderson et al. 2016). In addition, the 13th FYP also includes a cap on China's coal consumption to 5 billion tons of standard coal equivalent.

Besides, in 2011, the central government announced three provinces and four cities as carbon emissions trading pilots, which account for 27 % of China's GDP and covers regions with different development (Song et al. 2015). In December 2017, China officially launched its national trading scheme in the power sector (Central People's Government of the P.R.C 2017).

Given China's vulnerability to climate change impacts, the Chinese government published China's National Strategy for Climate Change Adaptation in 2013. It lays out clear guidelines and principles for climate change adaptation, specifies key targets, and outlines a wide range of measures for water protection, soil erosion minimisation, and disaster prevention to be implemented by 2020. In addition, climate change and rapid urbanisation in China has caused in increasing severe urban flooding. In 2015, the Chinese government initiated a Sponge City Programme (SCP), aimed at addressing urban flooding by allowing water to permeate, to flow into runoff capture systems, and to be collected and reused (Dai et al. 2016).

Responsibilities

Given its coordination role in economy development, the National Development and Reform Commission (NDRC), namely, its Department of Climate Change, led the formulation of key strategies, plans and policies on climate change and international climate change negotiations and international cooperation on climate change. Since 2018, the Ministry for Ecology and Environment (MEE) takes over all responsibilities on climate change held by NDRC. Except for MEE, various ministries lead climate mitigation and adaptation activities under their mandates. For example, the Ministry of Housing and Urban-Rural Development (MOHURD) is responsible for building energy efficiency and green building to mitigate GHG emissions of the building sector and for sponge cities to enhance cities' climate adaptation capacity. The NDRC leads national energy development and energy conservation strategy. Besides, the National Climate Change Leading Group was established in 2007, which is led by the Premier and consists of the heads of all relevant ministries and agencies. The Group is responsible for coordinating and reviewing major strategies and policies addressing climate change. The Group is hosted by MEE.

13.3 Water pollution and availability

Policy formulation and implementation

In 2012, the central government issued "the Views of the State Council on Applying the Strictest Water resources Control System". It includes Three Red Lines that sets binding limits of water consumption, use efficiency, and water quality. By 2030, annual national water consumption shall be limited to less than 700 billion m^3; water use efficiency in industry shall be below 40m^3 per 10000 Yuan GDP and irrigation use efficiency shall increase to more than 60%; more than 95% of water in water functional zone shall reach proper standard (Central People's Government of the P.R.C 2013). Besides the 2030 goals, the document also includes a set of milestones for 2015 and 2020. To achieve the targets and milestones, the document proposed the establishment of clear responsibilities of water resources management and an assessment system, including principle indices for the development, utilization, conservation and protection of water resources, to be a part of local official's evaluation system.

At the urban level, municipalities are required to prepare medium- to long-term urban water supply development and use plans for the development of water sources to meet urban demand. The preparation is coordinated with the water allocation planning framework at higher level to ensure the sustainable use of available resources (Cosier & Shen 2009).

In 2015, the central government issued the Water Pollution Prevention and Control Action Plan, which was jointly developed by 12 ministries and government departments. The plan aims at, by

2020: 1) improving water quality in key seven river basins (over 70% of water shall reach Grade III [1]or above); 2) improving drinking water quality (over 93% of urban drinking water shall reach Grade III or above); 3) reducing over-exploitation of groundwater and improves its quality (the share of groundwater with "very bad" category shall decrease to 15%): 4) improving urban water environment in key metropolitan regions (water with Grade V+[2] shall drop by 15% in the Beijing-Tianjin-Hebei region and be eliminated in the Yangtze River Delta and Pearl River Delta); 5) improving water quality of coastal areas. In order to reach the targets, 238 specific measures in total are involved, including control-and-command measures, economic and industrial transformation policies, science & technology promotion, and market mechanisms (MoST 2015). In addition, it clearly specifies the responsible bodies for every target and/or action.

Responsibilities

At the national level, water resources management, especially, in terms of water quantity, that influence the urban sector are primarily the responsibility of the Ministry of Water Resources and its line offices. They are responsible for determining the water allocated for different consumptive purposes within a river basin and within administrative regions through water abstraction permit system. The new Ministry of Ecology and Environment will be in charge of water quality and pollution control. The Ministry of Health sets drinking water quality standards that must be met by urban water suppliers. the National Development and Reform Commission regulates water pricing. The Ministry of Housing and Urban-Rural Development are technically responsible for the development of urban water sources and infrastructure (Cosier & Shen 2009).

13.4 Loss of biodiversity

Policy formulation and implementation

In 2010, the central government launched China's National Biodiversity Strategy and Action Plan 2011-2030 (NBSAB), which specifies a set of national targets for biodiversity conservation scheduled for the period of 2011-2030. To achieve the targets, ten action areas were prioritized, including improving the policy framework, integrating biodiversity into sectoral and regional plan, conducting survey, monitoring and evaluation of biodiversity, increasing natural conservation areas, implementing ex situ conservation scientifically, improving the management of invasive alien species and genetically modified organisms, contributing to climate mitigation, capacity building and education, and public participation and international collaboration on biodiversity (MEP 2010).

The central government has also promoted biodiversity at the city level. Biodiversity is incorporated as a key element in the national standard for garden cities issued by MHURD in 2010. The pilot program of eco-cities with good aquatic ecology was launched with the first 46 cities, in which biodiversity is mainstreamed into local economic and social development. 49 national urban wetland parks have already been created across the country, which aims at enhancing capacity of conserving and managing wetlands and wetland species in cities (MEP 2014).

Responsibilities

[1] It is applicable to the second class of protected areas for centralized sources of drinking water, protected areas for the common fishes and swimming areas.

[2] It is not useable for industrial or agricultural use.

The Ministry of Ecology and Environment (previously the Ministry of Environmental Protection) guides, coordinates, and oversees ecological conservation effort including biodiversity conservation in China.

13.5 Soil pollution

Policy formulation and **implementation**

In 2016, the central government released the Soil Pollution Prevention Action Plan, which was jointly developed by more than 18 ministries and government departments, as a response to the severe soil contamination in the country. The Plan sets key targets till 2030:

- by 2030, the safe utilisation rate of both contaminated agriculture land and contaminated industry waste land should be higher than 95%.
- Worsening soil pollution shall be curbed by 2020 and soil pollution risk is well controlled by 2030.

In terms of soil pollution resulted from brownfield, the Plan aims to:

- complete investigation of distribution and environmental impacts of contaminated land use of key sectors by 2020;
- reduce heavy metal emissions from key polluting industries by 10% from the 2013 level by 2020;
- encourage recycling of electronics, plastic and packaging waste

The implementation of the Plan requires a huge investment, which is estimated to be more than €1.15 trillion (Hu, 2016), while China's total budget for urban soil remediation in 2016 was only €0.77 billion. This tremendous financing gap poses a considerable challenge for soil protection in China.

Responsibilities

The Ministry of Ecology and Environment (previously the Ministry of Environmental Protection) is responsible for the supervision and administration of soil pollution in China.

13.6 Waste generation and management

Policy formulation and implementation

One key national strategic document for MSW is the 13th Five Year Plan (2016-2020) of residential MSW treatment and facility construction issued by both the the National Development and Reform Commission (NDRC) and the Ministry of Housing and Urban-Rural Development (MOHURD) (NDRC 2016). It aims to increase the daily treatment capacity to 1.1 million ton by 2020, in which incineration facilities shall account for more than 50% of the capacity. Besides, the utilisation rate of residential MSW shall more than 35%. Recycling and reuse system of food wastes shall be established in every city. The daily treatment capacity of food wastes shall reach 34400 ton per day.

In the recent years, Chinese government has paid increasing attention on building waste utilization. The 2015 Circular Economy Promotion Plan promotes building waste recycling and reuse. National guidelines and pilots plan are being drafted (NDRC 2015b).

Responsibilities

The Ministry of Ecology and Environment (previously the Ministry of Environmental Protection) is mainly responsible for the supervision and administration of MSW control. In case of building wastes and construction of facilities, the Ministry of Housing and Urban-Rural Development (MOHURD) plays a major role.

13.7 Summary

In China, the National People's Congress (NPC), the State Council, and the Communist Party of China (CPC) are the three key decision-making bodies at the highest level. The supreme source of law in China is represented in principle by NPC. The State Council executes laws and supervises the government bureaucracy and thus carries out the administrative functions of the central government. Subordinate to the State Council are 22 ministries, 7 commissions, and 42 direct organs and institutions. The CPC can influence the law-making process by appointing NPC's Standing Committee and top positions in ministries and commission.

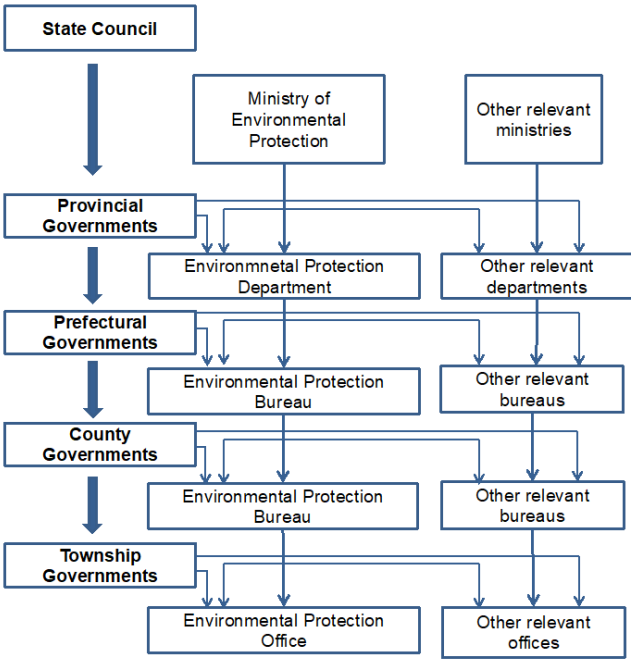
The administrative units under the central government are organized in a three-tier system. The first level includes 23 provinces, 5 autonomous regions, and 4 municipalities. The second level consists of four different types: autonomous prefectures, counties, autonomous counties and cities. The third level composed of townships, ethnic minority townships, and towns. Each ministry has its line office at each administrative level.

Every five years, the central government unveils its Five-Year Plan (FYP), which guides the country's overall economic and social development in the upcoming five years. Based on this FYP, a set of FYPs with specific sectoral or cross-sectoral focus are issued by a ministry or a governmental department or co-issued by several of them. Corresponding overall and sectoral or cross-sectoral FYPs are then developed at both first and second administrative levels.

Governance of environmental protection

The environmental governance structure in China exhibits a complex nature (see Figure below). On the one hand, given the hierarchical structure in China, the environmental policies are usually implemented in a top-down manner, i.e. from the responsible ministry reaching down to its line offices at different administrative levels. On the other hand, the line offices are also a part of territory government at specific administrative levels. Thus, the line offices have to report to both vertically and the local government. This dual structure leads to the complexity of urban environmental governance. The local governments who have large degree of autonomy tend to selectively implement environmental policies of the central government, considering their local needs.

Figure 9: Chinese authorities in the field or urban environmental protection



Source: Own illustration, Wuppertal Institute (Other key relevant ministries leads environmental protection activities under their mandates, such as the Ministry of Transportation, the Ministry of Industry and Information Technology, the Ministry of Water Resource, the Ministry of Agriculture, etc.)

At the national level, since March 2018, the new Ministry of Ecology and Environment absorbed functions originally under other ministries and is responsible for environmental-related issues in various fields, such as climate change mitigation, water pollution and protection (both surface and underground), agriculture pollution, etc. The following Table 15 summarises the national policies that aim to tackle environmental challenges at the urban level, as well as their status and ambition.

Table 15: National policy implementation regarding urban environmental challenges in China

Challenge	Policies	Status and ambition	Priority
Air pollution	Air Pollution Prevention and Control Action Plan (2013)	1) To reduce annual average PM2.5 concentration in three key metropolitan regions (Beijing-Tianjin-Hebei region, the Yangtze River Delta, and Pearl River Delta by 25%, 15%, and 10% compared to 2012 levels, respectively); 2) to reduce the concentration of PM10 by 10% in all cities compared to 2012 levels; 3) reduce PM2.5 levels in Beijing from 89.5 µg/m3 in 2013 to 60 µg/m3 Implementation: According to the middle-term evaluation, the overall air quality of urban areas had improved. However, air quality in the winter time was still severe. It was expected all targets can be	High

Challenge	Policies	Status and ambition	Priority
		fulfilled.	
Climate change and its effects	China's commitment of „Enhanced actions on climate change" (2015)	To reduce its carbon intensity by 60-65% from 2005 levels by 2030, peaking its carbon emissions by 2030, increasing non-fossil-fuel energy to 20 % of its energy mix, and expanding forested land. China has made significant progress by, for example, decreasing its reliance on coal, increasing clean energy, and adjusting its economy structure. Some studies predict that China would peak its carbon emissions already by 2025 (Website WRI).	High
	13th Five- Year Plan (2016 -2020)	Targeting at a 15% energy intensity reduction and an 18% carbon intensity reduction by 2020, compared to 2015 level.	
	China's National Strategy for Climate Change Adaptation	It outlines a wide range of measures for water protection, soil erosion minimisation, and disaster prevention to be implemented by 2020.	
Water pollution and availability	the Views of the State Council on Applying the Strictest Water resources Control System (2012)	By 2030, annual national water consumption shall be limited to less than 700 billion m3; water use efficiency in industry shall be below 40m3 per 10000 Yuan GDP and irrigation use efficiency shall increase to more than 60%; more than 95% of water in water functional zone shall reach proper standard.	High
	Water Pollution Prevention and Control Action Plan (2015)	By 2020: 1) improving water quality in key seven river basins (over 70% of water shall reach Grade III 3or above); 2) improving drinking water quality (over 93% of urban drinking water shall reach Grade III or above); 3) reducing over-exploitation of groundwater and improves its quality (the share of groundwater with "very bad" category shall decrease to 15%): 4) improving urban water environment in key metropolitan	

[3] It is applicable to the second class of protected areas for centralized sources of drinking water, protected areas for the common fishes and swimming areas.

Challenge	Policies	Status and ambition	Priority
		regions; 5) improving water quality of coastal areas.	
Loss of biodiversity and destruction of the natural landscape	China's National Biodiversity Strategy and Action Plan 2011-2030 (2010)	Setting a set of national targets for biodiversity conservation in the period of 2011-2030 and identifying ten areas of key actions. Biodiversity is incorporated as a key element in sustainable cities guidelines and standards.	High
Land sealing and soil degradation	Soil Pollution Prevention Action Plan (2016)	by 2030, the safe utilisation rate of both contaminated agriculture land and contaminated industry waste land should be higher than 95%. Soil pollution shall be curbed by 2020 and soil pollution risk is well controlled by 2030	High
Waste generation and management	13th Five Year Plan (2016-2020) of residential MSW treatment and facility construction	By 2020, the daily waste treatment capacity will be increased to 1.1 million ton.	High

Source: Own compilation and own priority assessment based on literature analysis, Wuppertal Institute

14 Political priorities in South Africa

This section describes principal areas of national action. The formulation of key national policies to tackle these challenges are analysed with a view to understand their ambition and stringency.

14.1 Air pollution and acid rain

Policy formulation and implementation

In 2004, the South African government published the National Environmental Management: Air Quality Act (NEM:AQA) and a revised version published in 2013 that recognises issues such as air pollution and its impacts on health. This legislation includes an atmospheric licensing system, which requires that any operation producing air pollution – which in terms of the Act is referred to as an atmospheric emission – must ensure that they have in place an effective air quality management plan. The NEM:AQA sets out the legal requirements for Air Quality Officers and Licensing Authorities to implement and monitor the atmospheric emission licensing system (Department of Environmental Affairs of South Africa 2018).

The NEM:AQA also includes a guiding mechanism that prescribes for the NEM:AQA to be revised every five years and includes the monitoring of air quality by municipalities. Furthermore, the NEM:AQA promotes the access for the population to information about air quality. However, the AQA does not include direct implementation of emission standards that would allow for penalising those that exceed threshold emissions (Groundwork, 2014). In addition, South Africa´s National Report for Habitat III mentions air pollution explicitly as one challenge for the New Urban Agenda.

The promulgated Air-Quality Regulations and the National Environmental Management: Air Quality Act (NEM:AQA) also has an additional clause to ensure the imposing of a carbon emissions tax – the bill has been approved by Cabinet during May 2018 and is currently within the SA's national parliament process. According to the National Report for Habitat III, although South Africa has committed to reduce its CO_2 emissions to 34%, with international financial and technological, help by 2020 yet two new coal-fired power stations are being constructed in Limpopo and Mpumalanga. "Clearly these additional units will add to South Africa´s already high levels of CO2 emissions" (South Africa Habitat National Team, n.d.).

South Africa has also implemented ambient air quality standards, which are monitored with the aid of actual measurements, emissions inventories and dispersion modelling and emission reduction measures (see chapter 0 for the actual thresholds).

Responsibilities

The democratic constitution of South Africa, Act 108 of 1996, enshrines fundamental rights to the protection of the environment. Section 24 of South Africa's constitution enshrines a two-fold purpose right that, firstly, guarantees a healthy environment to every person, and secondly mandates the State to ensure compliance with the first part mentioned above. In addition, the State is prohibited from any infringement on the right to environmental protection and is required to provide protection against any harmful conduct towards the environment (Polity, 2018). Practically, the Department for Environmental Affairs of South Africa is mandated to be responsible to ensuring adherence to the constitution. Insomuch, it has been fundamentally responsible for the development of air quality management legal instruments such as the National Environmental Management Act (1998), the White Paper on Integrated Pollution and Waste Management for South Africa (2000) or the National Environmental Management: Air Quality Act (2005). At the same time, "direct responsibility of air quality management was

shifted from national government to local authorities. Metropolitan, district and local municipalities that need to work cooperatively with national and provincial authorities in managing air quality" (ENVASS 2017). In that context, however, the communication and cooperation between various levels of authorities remains a challenge.

14.2 Climate change and its effects

Policy formulation and implementation

In an international context, South Africa committed to adopt effective measures to achieve its iNDCs under the Paris Agreement. These include for instance the decarbonization of electricity by 2050, the introduction of electric vehicles and the development of a national climate change adaption plan. South Africa is involved in several joint projects with the EU, with the goal of improving water management in South Africa for instance, or the development of urban low emission strategies (EC 2020).

n 2009, South Africa has committed to reduce GHG emissions by 34 per cent by 2020 and 42 per cent by 2025 under the condition of international financial and technological support (EDF & IETA 2014, Wills, 2010). In that context, since 2009, the South African government is discussing the implementation of a carbon tax versus the introduction of an emissions trading scheme. In 2013, the implementation of a carbon tax way forward was decided (EDF & IETA 2014), specifically to support the functioning of this tax the SA government introduced several other measures such as the Energy Efficiency and Energy Demand Management, the Integrated National Electrification Programme as well as the Renewable Energy Independent Power Producers procurement initiative. The administration of President Jacob Zuma had influenced many of the policy decisions in regards to energy policy and the country's transition to sustainable energy sources. The Department of Energy's Integrated Resource Electricity Plan and the Government's Carbon Tax where delayed for two years, the state owned utility provider, Eskom, only recently signed power supply contracts with renewable companies – delaying the attractiveness of the renewable energy sector to potential investors. South Africa's Nationally Determined Contribution (NDC) contains a target to limit GHG emissions between 398 and 614 MtCO2e over the period 2025–2030. This target is equivalent to a 19–82% increase on 1990 levels excl. LULUCF. Importantly, in 2017 the South African administration implemented the Greenhouse Gas Emission Reporting Regulations (GHG Regulations) that require both businesses and individuals to register and report on their greenhouse gas emissions.

One main aspect to reduce GHG emissions at the urban level is the development of a more comprehensive spatial transport strategy, in particular in urban settlements. The National Department of Transport has published several documents that emphasize the need for local, regional and national freight strategies (e.g. National Land Transport Act, National Freight Logistics Strategy, Road Freight Strategy) (Jennings 2017). Although taking these policies into consideration, the Climate Action Tracker rates South Africa´s commitment to reduce GHG emissions as "inadequate" and not in line with the 2°C threshold (Climate Transparency 2017). Moreover, local existing informal transport modes - remnants from apartheid – have not been incorporated or consulting in the formalising of public transport strategies.

Responsibilities

South Africa's key policy to reduce the GHG emissions is the Integrated Resource Electricity Plan (IRP) 2010-2030 – this policy would also implement a target renewable capacity of total 17.8GW for 2030. The state-owned energy operator, Eskom, is responsible for the full IRP implementation. The Plan was initiated and planned to be revised every second year by the Department of Energy (IRP 2010). However, this revision never took place and "failed to

adequately meet the constantly changing supply and demand scenarios in South Africa, nor did it reflect global technological advancements in the efficient and responsible generation of energy" (CDH 2019). Therefore, the South African Department of Energy updated the IRP in 2019. Although coal continues to be a significant energy source for electricity generation, the updated plan now focuses on investments into more efficient low emission technologies (CDH 2019).

14.3 Water pollution and availability

Policy formulation and implementation

The right to sufficient water is fixed in various legal documents such as South Africa´s Constitution, and the Water Services Act (Government of South Africa 1997). Other legal documents concerning water availability and quality management include the National Water Act, the Water Services Act, the National Environmental Management Act, the National Water Resource Strategy as well as the Strategic framework for water services. These are combined with regulations, "regulating processes or products, limiting the discharge of specified pollutants, and by restricting certain polluting activities to specific times or areas" (Department Water and Sanitation South Africa 2016). However, these measures are often considered as inefficient.

South Africa introduced, for instance, in 2005 the Western Cape Reconciliation Strategy including methods such as leakage repair, pressure management, user education and microeconomic tools. However, according to the Environmental Monitoring Group, these measures are not efficient enough. For instance, they recommend the installation of public rainwater tanks instead of individual private tanks due to their larger storage capacity and the potential use for domestic purposes such as flushing toilet. However, institutional barriers prevent the installation of these larger rainwater tanks (Pereira n.d.). The post-apartheid National Water Act is considered to be one of the most advanced policy documents globally – its framework asserts that people and the environment have a constitutional right to water, although the practical attainment of the provisions has yet to be realised (Small, local solutions can crack water crisis: A South African Case Study, 2018).

Responsibilities

The national department of water affairs is the lead department in all matters related to water in South Africa and two laws govern this area of competence, namely the National Water Act, 1998, and the Water Services Act, 1997. The National Water Act directs how South Africa enables the use of water to communities specially with the vagaries of climate change and the demands of a growing population. It also identifies what the different tiers of government and water users should do and procedures to follow. The Water Service Act is responsible for water resource planning, development and management as well as infrastructural systems whereas individual municipalities serve as "Water Service Authorities", responsible for the provision of water access to the population (NWRS 2013). The national water Act requires the Minister of Water Affairs to deliver a national water resource strategy every five years – this requirement have not been fully complied with by the relevant Minister.

14.4 Desertification and land degradation

Policy formulation and implementation

Based on the 10-year Strategy of the United Nations Convention to Combat Desertification (UNCCD) of 2007, South Africa introduced the National Action Programme to combat desertification as well as several other direct or indirect regulations with regards to land

degradation (e.g. Environmental Conservation Act, Conservation of Agricultural Resources Act etc.) (Department of Environmental Affairs, South Africa 2012).

Responsibilities

Although South Africa´s government introduced several reforms, acts and regulations with regards to soil degradation and desertification, these reforms and regulations are administered by different departments of the South African government "with the result that the public seldom knows where to report incidents of environmental abuse and even if such incidents are reported, little effective action is taken against the offenders" (Department of Environmental Affairs, South Africa 2012). Therefore, amongst others, the South African government has initiated community-based programmes aimed at local mitigation strategies to combat desertification and land degradation (ECOSOC 2007).

14.5 Loss of Biodiversity

Policy formulation and implementation

On a national scale, several laws and regulations were developed with regards to South Africa´s maintenance of biodiversity such as the Protected Areas Act (2003) or the Biodiversity Act (2004). On a regional scale, provincial departments are in charge of implementing these regulations. On a local level, private owners are encouraged to protect local biodiversity through Stewardship Programmes (e.g. including tax incentives) (Brownlie et al. 2017). However, there is a lack of a clear policy on biodiversity issues. According to Brownlie et al. (2017), South Africa´s national policy on biodiversity does not include an adequate implementation framework, resulting in delays in applications of national strategies on a provincial level.

Responsibilities

On a national scale South Africa´s Department of Environmental Affairs is responsible for the management of the country´s biodiversity. On a regional scale, however, provincial departments are in charge of the biological and ecological maintenance of the ecosystem (Brownlie et al. 2017).

14.6 Waste generation and management

Policy formulation and implementation

In 2009, the South African Government introduced the National Environmental Management Waste Act, emphasizing the need for a national waste management strategy, the declaration of priority waste streams, setting recycling targets as well as the ban of certain waste streams from landfills (Department of Environmental Affairs South Africa 2012). However, despite of the recycling objectives, only 10% of South Africa´s waste industry includes recycling techniques (GreenCape 2017). Most of South Africa´s waste is still being transported to landfills; in particular e-waste disposal is worrisome since its growth is three times faster than other waste forms (Infrastrucuturene.ws 2017).

Responsibilities

On a micro-scale, municipalities or service providers are in charge of household waste management. Industrial waste in turn is managed by the private sector (GreenCape 2017). On a macro-scale, waste management is supervised by the South African Department of Environmental Affairs. South Africa has invested in it recycling economy over the past three decades – with much activity influence from the informal sector. The national government of south Africa has intentions to grow the waste and secondary resources sector from 0.51% of

GDP to between 1.0-1.5% of GDP, helping leverage the benefits to low income people, reducing the burden of poverty and unemployment. South Africa has a complex waste policy landscape with 40 pieces of legislation that deals with waste management – a streamlined waste policy landscape would complement better waste management services and infrastructure of South Africa.

14.7 Summary

South Africa is a parliamentary republic, being governed on three levels (which together form a so-called cooperative governance). The national government consists of 41 ministerial departments. On the regional level, the country consists of 9 provinces that are governed by unicameral legislatures. Provincial (shared) responsibilities are listed in the national constitution and include amongst others the fields of agriculture, environment, human settlements, nature conservation, regional planning and development, as well as urban and rural development. The National Council of Provinces is represented at the national parliament and ensures that provincial interests are taken into account (Provincial Government Handbook 2019). On the municipal level, there are in total 278 municipalities, consisting of three different types of municipalities: There are 8 metropolitan, 44 district and 226 local municipalities. Non-metropolitan municipalities are responsible for various tasks such as the establishment, implementation and revision of local performance management systems, budgetary issues, provision of municipal services and the communication and dissemination of information with respect to governmental matters to the population (South African Yearbook 2018/19). All governmental levels (national, provincial and local) are defined as "distinctive, interdependent and interrelated" governmental authorities, that have legislative as well as executive power (South African Government 2020).

Governance of environmental protection

The key player in protecting the environment at the national level is the Department of Environmental Affairs (DEA). It is in charge of environmental management, environmental conservation and protection, the promotion of an environmentally sustainable and low-carbon green economy, the development of climate adaption and mitigation regulatory framework, the improvement of the quality of waste-management services, as well as the ensurance of legal compliance with environmental compliance. To sustain a green economy, the DEA developed the Green Economy Strategy, including eight pillars (South Africa Yearbook – Environment 2018/2019): the promotion of green buildings, a sustainable transport and infrastructure, a clean energy and energy efficiency, the conservation and management of natural resources, the management of sustainable waste and water, the promotion of sustainable consumption and production as well as the sustainability of agriculture food production and forestry. The work of the DEA is sustained by various institutions, such as the South African Weather Service (SAWS), the iSimangaliso Wetland Park, the South African National Biodiversity Institute (SANBI) as well as the South African National Parks (SANParks). Besides the DEA, also the Department of Energy is in charge of some areas regarding environmental protection, in particular with respect to GHG emission reductions. In that context, it envisages a 30 per cent clean energy share by 2025 (Department of Energy n.d.). Moreover, issues regarding water pollution and availability are regulated by the Department of Water Affairs.

Various areas belong to the legislative competence of both national and provincial authorities. These include amongst others the administration of indigenous forests, agriculture, environmental matters, housing, nature conservation pollution control, public transport, urban and rural development and soil conservation. The South African Constitution gives exclusive

legislative power to principal governments in some fields, such as provincial planning, roads and traffic, liquor licenses and others (South African Government n.d.).

Local authorities in turn are in charge of various other fields, such as building regulations, electricity and gas reticulation, municipal public transport services and trading regulations. Environmental issues are, hence, regulated primarily on a national or provincial level (South African Government n.d).

Figure 10: South African authorities in the field or urban environmental protection

Source: Own illustration, Wuppertal Institute

Based on the above sections, the following Table 16 summarizes the national policies that aim to tackle environmental challenges at the urban level, as well as their status and ambition. The priority assessment in the right-hand side column is an own assessment based on the criteria as outlined in the Methodology section.

Table 16: National policy implementation regarding urban environmental challenges in South Africa

Challenge	Policies	Status and ambition	Priority
Air pollution	Air Quality Act (AQA), 2004 & revised version in 2013	recognises issues such as air pollution and its impacts on health. The AQA includes a guiding a mechanism within it that prescribes a requirement for the AQA to be revised every five years and includes the monitoring of air quality by municipalities. Although the AQA does not include direct implementation of emission standards that would allow for penalising those that exceed threshold emissions	High
	National Air Quality	to combat air pollution on a national	

Challenge	Policies	Status and ambition	Priority
	Management Programme 2000-2010	basis	
	National Green Fund	Support the transition to a low carbon, resource-efficient and climate resilient development path and has allocated ZAR800m for this endeavour	
	Carbon Emissions Tax	in the Parliamentary Processes	
	Energy Efficient Motors Programme	supports the limitation of vehicle emissions	
	Clean Transportation Policy	development of bus rapid transit system throughout all major cities. Investments into a South African Electric car development programme	
Climate change and its effects	Carbon tax	Support the functioning of this tax the SA government introduced several other measures such as the Energy Efficiency and Energy Demand Management, the Integrated National Electrification Programme as well as the Renewable Energy Independent Power Producers procurement initiative. Was delayed for 2-years, In May 2018 parliamentary processes begun to make the bill into law.	High
	Renewable Energy Independent Power Producers, Energy Efficiency and Energy Demand Management, the Integrated National Electrification Programme	Was delayed for 2 years. Recently signed power supply contracts with renewable companies – delaying the attractiveness of the renewable energy sector to potential investors	
	Greenhouse Gas Emission Reporting Regulations (GHG Regulations, 2017	Require both businesses and individuals to register and report on their greenhouse gas emissions.	
	Integrated Resource Electricity Plan (IRP) 2010-2030	This policy would also implement a target renewable capacity of total 17.8GW for 2030. The state-owned energy operator, Eskom, is responsible for the full IRP implementation.	
Water pollution and availability	South Africa´s Constitution basic right to water is protected & the Water Services Act	These are combined with regulations, “regulating processes or products, limiting the discharge of specified pollutants, and by restricting certain polluting activities to specific times or	High

Challenge	Policies	Status and ambition	Priority
		areas"	
	National Water Act, the Water Services Act, the National Environmental Management Act, the National Water Resource Strategy as well as the Strategic framework for water services.	South Africa's water policies and national legal framework is considered to be one of the most advanced policy documents globally – its framework asserts that people and the environment have a constitutional right to water, although the practical attainment of the provisions has yet to be realised	
Desertification and soil degradation	National Action Programme to combat desertification & Environmental Conservation Act, Conservation of Agricultural Resources Act	Overlapping policies and legislation. Resulting in lack of direction to public information and public unaware of proper authority	Medium
Waste generation and management	National Environmental Management Waste Act,	Emphasizing the need for a national waste management strategy, the declaration of priority waste streams, setting recycling targets as well as the ban of certain waste streams from landfills. 10% of South Africa´s waste industry includes recycling techniques. Waste is still being transported to landfills. Public policy and education on waste recycling not fully implemented.	Medium
Loss of biodiversity	Protected Areas Act (2003) & the Biodiversity Act (2004). Stewardship Programmes and community initiatives	National policy on biodiversity does not include an adequate implementation framework, resulting in delays in applications of national strategies on a provincial level. Lacking policy direction	Low to medium

Source: Own compilation and own priority assessment based on literature analysis, Wuppertal Institute

15 Political priorities in Indonesia

This section describes principal areas of national action. The formulation of key national policies to tackle these challenges are analysed with a view to understand their ambition and stringency.

15.1 Air pollution

Policy formulation and implementation

Air pollution has been explicitly mentioned in Indonesia's National Report for Habitat III (Indonesia Habitat National Team 2016). However, apparently, a strategy to tackle air pollution coherently and comprehensively has not been identified yet. A study carried out by United Nations Environmental Programme (UNEP) (UNEP 2015) came to a similar conclusion. It seems as if the Indonesian Government approaches air pollution through implementing policies in different sectors, through which air quality improvements as co-benefits are possible.

Indonesia's National Ambient Air Quality Standards cover several substances (e.g. PM10, SO2, NO2, CO), which are less ambitious compared to WHO standards. Cities are supposed to comply with these standards (ADB 2010). In order to monitor the level of air pollution, the Standard Pollution Index (SPI) is used, which can be accessed online (Indonesia Habitat National Team 2016). According to the report for Habitat III, only 19 municipalities or regions make use of this tool.

In the transport sector, the NAMA SUTRI (Sustainable Urban Transport Program) aims at developing demonstration projects, at first in seven pilot cities, for various urban (passenger) transport improvements, such as new bus fleets and sustainable urban infrastructure development. For instance, the use of natural gas for public transport is seen as an instrument to improve air quality (MoEF 2015). Apart from that, this internationally supported framework programme seeks to develop a coherent national urban transport policy and establish a technical support unit with the Ministry of Transport (MoT) assisting local governments in project implementation (NAMA Facility 2017). Indonesia has been one of three countries in Asia that so has not made use of Euro 4-standards for vehicles (LoC 2017); however, "new gasoline vehicles meet Euro 4 emission standards starting in September 2018 and all new diesel vehicles to meet Euro 4/IV emission standards starting in April 2021, replacing the current Euro 2/II emission standard requirements" in line with Regulation on the Standard Exhaust Emission of Euro 4-Type Mo-tor Vehicles (ICCT & DieselNet 2018). Car-free (sun)days implemented by local authorities appear to have limited effects.

Air pollution from waste (dumps) was tackled through waste management law 18/2008 since it establishes a comprehensive framework. However, one of the objectives addressing municipalities to establish plans for closing or upgrading open waste dumps has not been realised as of 2016; 90% of disposal sites are still considered to be "open" (ekonid 2016). City air pollution is specifically addressed through an improved natural gas network aiming at close to 100.000 households (MoEF 2015).

International cooperation from Germany, Japan and multilateral institutions support Indonesia in limiting air pollution directly or indirectly through financial assistance or technical support. For instance, the German bilateral cooperation finances the rehabilitation of waste dumps according to modern standards and supports the development of sustainable urban transport systems (KfW 2017, GIZ 2010).

Responsibilities

As air pollution is cross sector, there are different actors responsible. However, on the national Ministry of Environment and Forestry (MoEF) is responsible for forest protection and for preventing the illegal burning of forests, which may also affect air quality in Indonesia's North (CI-FOR 2015). Apart from that MoEF sets threshold limit values for emissions. Provincial governments (but *not* municipal authorities) are allowed to establish more standards more ambitious than national ones (ADB 2010). The municipal level is in charge of district spatial planning (Rukama 2015, CIFOR 2015). In this respect, municipalities may allocate bike lanes, they can lead by example (e.g. by cycle-to-work) or promote of car-free "days" (Indonesia Habitat National Team 2016). With respect to emissions, the national Ministries of Transport (MoT) and Energy and Natural Resources (MoENR) may implement policies that can contribute to clean air. The Ministry of National Development Planning (BAPPENAS) and the MoT can be considered important partners for international donors in implementing the NAMA Sutri framework programme (NAMA Facility 2017).

15.2 Climate change and its effects

Policy formulation and implementation

Indonesia has been committed to cut GHG emissions unilaterally by 29% by 2030 relative to Business As Usual (BAU) baseline. Together with international support, the Government seeks to curb emissions by 41% by 2030 (Government of Indonesia 2016). However, according to CAT (2018) confusion revolves around the latter target also set at only 38%. The forestry sector is supposed to contribute the highest share to emission reductions envisioned.

The National Action Plan for Greenhouse Gas Emission Reduction forms the cross-sectoral framework for Indonesia's climate strategy. The Action Plan, also called RAN-GRK, formulates seven key mitigation sectors, including forestry, energy efficiency, renewable energy, solid and liquid waste and transport directly or indirectly contributing to improving air quality. The document is considered to be a guideline for national ministries and regional and local governments (IEA 2015). In line with the sector identified nationally, regional authorities are also supposed to develop Regional Action Plans for Greenhouse Gas Emission Reduction (RAD-GRK) which includes the development of a strategy for emission reductions as well as proposal for local GHG mitigation actions.

According to the National Energy Policy, Indonesia intends to increase renewable energy to 23% of total primary energy supply by 2025. However, planned investments in fossil power stations, particularly coal, pave the way for a carbon-intensive energy future. According to the GBPN (n.d.) Indonesia introduced energy standards for buildings and building technologies covering i.e. the building envelope, air conditioning and lighting. However, regulations requiring buildings to consider energy conservation fail due to a lack of enforcement. The Energy Management Regulation No. 14/2012 in line with Government Regulation of the Republic of Indonesia No. 70/2009 on Energy Conservation re-quires certain businesses consuming more than 6.000 toe to implement an energy management. In 2015, a benchmark for energy managers was implemented, as well. As stipulated in Presidential Instruction on Mandatory Energy Conservation of Government Office Buildings (No. 10/2005) it is compulsory for government agencies and regional governments to realise energy saving measures according to guidelines on energy saving in government buildings (IEA 2015).

The Indonesian government considers mitigation and adaptation efforts as an integrated concept that is essential for building resilience in safeguarding food, water and energy resources (Government of Indonesia 2016). The Climate Change Adaptation Plan (RAN-API) provides a framework for adaptation initiatives. The government plans to map regional vulnerabilities as

the basis of an adaptation information system, and to strengthen institutional capacity to understand and implement appropriate „climate change sensitive policies“ (ibid.). The medium-term goal of Indonesia’s climate change adaptation strategy is to reduce risks on all development sectors, including the urban systems. According to LSE (2015), the plan itself does not have a formal legal basis, [but] it is an important input into the development of the Government Annual Plan as well as the National Medium-Term Development Plan.“

Responsibilities

On the national level, the Ministry of National Development Planning (BAPPENAS) coordinates climate change issues; for instance, it publishes the Climate Change Sectoral Roadmap (ICCSR), which serves as the basis for leading and coordinating the formulation of Indonesia’s climate change strategy (RAN-GRK). According to Mersmann et al. (2017) it takes on a leading role in adaptation policies. The MoEF is considered to be the important ministry in formulating Indonesia’s overall climate change approach (Mersmann et al. 2017). The responsibilities of subnational governments are similar to those regarding air pollution: establishing ambitious emissions limits, lead-by-example policies etc. In the Jakarta area, a green building code was introduced (GBPN n.d.). With respect to emissions, the MoT and Ministry of Energy and Natural Resources may implement policies that can contribute to mitigate climate change.

15.3 Water pollution and availability

Policy formulation and implementation

The State Ministry of Environment and Forestry has implemented some national programs connected to water management and pollution control, including for instance a system which evaluates water quality all over the country; and a clean river program. In 2009, the national government led by MPWH and BAPPENAS launched the program for the Acceleration of Sanitation Development in Human Settlements, which aimed at improving sanitation in around 330 cities. In the wake of this programme, „budgets have risen by 800 % (2006 to 2012)“ (Blackett et al. 2017). A second phase of the programme was launched. For the period from 2015 to 2019, the Government launched the 100-0-100-targets which refer to 100% of households having access to clean water with slums being eradicated and all households having access to safe sanitation (World Bank 2016). In relation to these targets, the World Bank provided a loan of USD 216 million for the National Slum Upgrading Project.

Responsibilities

The MPWH is in charge of operating river infrastructure (multipurpose dams, weirs) as well as canals of the irrigation system. MPWH’s Directorate General *Cipta Karya* has authority over for water supply and sanitation. The Ministry of Health regulates drinking water standards and monitoring of drinking water quality provided by water supply agencies. MoEF controls pollution levels and river zoning. MoENR supervises the quantity and quality of groundwater and licenses groundwater drills. Local water utilities safeguard delivery to customers. On the provincial level in Java, the reporting of pollution of shallow groundwater is carried out by the Java Water Resources Strategic Study (ADB 2016).

15.4 Noise pollution

Policy formulation and implementation

Donor agencies seek to improve air quality through sustainable modes of transportation. Noise pollution appears to be a relatively neglected issue.

Responsibilities

Noise pollution is not a priority on Indonesia's political agenda. Therefore, currently no ministerial branch can be listed to be in charge of regulating noise limits or reducing noise pollution. Since noise represents, nevertheless, a problem that accompanies the rising volume on traffic, noise pollution might be put on the agenda in Indonesia by international donors and cooperation in the medium term.

15.5 Loss of biodiversity and destruction of the natural landscape

Policy formulation and implementation

Indonesia formulated a Biodiversity Strategy and Action Plan (IBSAP) for 2015 to 2020 (IBSAP, BAPPENAS 2016). The IBSAP is integrated into the Medium-Term National Development Plan. It was formulated by the National Development Planning Agency, the Indonesian Institute of Sciences and the Ministry of Environment and Forestry. Since the economic value of biodiversity and the country's ecosystem is relevant for Indonesia's economic wellbeing (e.g. in 2012 biodiversity contributed up to 329.9 million US$ to economic welfare in Indonesia), the IBSAP represents a "solid foundation to build a common understanding about the importance of protecting its biodiversity and the far-reaching social, economic and environmental benefits" (UNDP 2016). As such the IBSAP is aimed at encouraging the realization of the SDGs.

Responsibilities

BAPPENAS and MoEF formulate important framework measures (IBSAP) CBD n.d., MoEF 2014), which shall include instruments to monitor and evaluate the implementation progress at both the national and the local levels. Other authorities include amongst others the Ministry of Marine Affairs and Fisheries and the MoEF which are in charge of integrating biodiversity into their sectoral strategy plan (CBD n.d.).

15.6 Land sealing and soil degradation

Policy formulation and implementation

Spatial Planning Law 26/2007 requires the share of green open (public or private) spaces to be at least 30%, the share of forests in river stream areas must be 30%, as well, which may contribute to improve air quality. Sanctions as well as incentives and disincentives are provided on paper. However, enforcement of green spaces remains week (Indonesia Habitat National Team 2016).

Responsibilities

In the wake of government decentralisation, municipalities received authority for urban planning. However, the national MPHW issued a guideline for spatial planning. Apart from that, the national government seeks to facilitate the green spaces in urban areas, even though it remains unclear which entity is in charge of monitoring the quantitative target for green spaces in Indonesia.

15.7 Land subsidence

Policy formulation and implementation

A coherent strategy to tackle land subsidence has not been identified. For Jakarta, a Coastal Defence Strategy (JCDS) was developed in cooperation between the MPWH (Government of Indonesia) and the Government of The Netherlands. Among other things, the JCDS-study concludes that "[l]and subsidence can only be stopped, if deep ground water extraction is

replaced by piped water supply" (Brinkmann 2012). Sources suggest that municipalities apply instruments accordingly. For instance, in Jakarta, the Governor issues permits allowing the extraction of groundwater or surface water for commercial purposes. Moreover, a higher tax is applied to groundwater resource extraction. A "zero deep well" programme was introduced affected both, industry and households. While it aims at accelerating the expansion of the water network, it is unknown whether the programme has completed prohibited the drilling of deep wells. Jakarta Spatial Master Plan intends to conserve water resources. Zoning regulations includes carrying capacity limits in order to prevent land subsidence as a result of surface pressure. In Semarang, the Government makes use of regulations (e.g. drilling restrictions), information campaigns and facilitates the rehabilitation of damaged houses by factoring in light materials (Saputra et al. 2017).

Responsibilities

Land subsidence is in the hands of local authorities, while the national government may become involved as shown in the development of the JCD-study.

15.8 Waste generation and management

Policy formulation and implementation

According to World Bank 2017, the National Medium Term Development Plan's (RPJMN) puts waste management high on the national agenda. According to the country's NDC, the Government seeks to develop a "comprehensive strategy" for the waste management sector and to facilitate the "policy and institutional capacity at the local level, enhance management capacity of urban waste water, reduce landfill waste by promoting the 'Reduce, Reuse, Recycle' approach, and the utilization of waste and garbage into energy production" (Government of Indonesia 2016). Former instruments introduced did not have the envisaged effects. For instance, the MPWH mandated through regulation 21/Prt/M/2006 to close open dump landfills or upgrade those to sanitary facilities by 2011 (ekonid 2016, World Bank 2017). The Waste Management Act (No. 18/2008) obliged municipal authorities to close open dumping sites by 2013. However, "open unsanitary landfills remain the norm" (World Bank 2017).

Responsibilities

Municipalities are considered to be the primary implementing actors for waste management issues according to the Waste Management Act (No. 18/2008). Municipal planning agencies (BAPPEDAS) and municipal cleansing units are in charge of planning and implementing solid waste management at the local level.

The MPWH is – simply speaking – limited to the provision of technical advice, to facilitating and carrying out pilot projects and to monitoring large-scale off-site solid waste facilities. On the national level, MoEF is another important actor as regards policies and regulation and the coordination of pollution control efforts (World Bank 2017).

15.9 Summary

Indonesia has currently 34 ministries, which are organised under four coordinating ministries for:

- Political, Legal, and Security Affairs;
- Economic Affairs;
- Maritime Affairs and Natural Resources;

- Human Development

Indonesia has made a strong push towards decentralisation, giving regional and local political levels much more economic and political autonomy than under the former Suharto regime. In recent years, there has been a trend back towards partial centralisation of political powers. This has created a complex web of governance that is not always clear as to whom decision-making power ultimately falls. Political experts have claimed that Indonesia's governance system is subject to clientelism and vested interests of powerful economic stakeholders such as the palm oil and coal mining industry (Di Gregorio et al. 2017).

Governance of environmental protection

In order to mitigate the urban environmental challenges identified in Indonesia, a relatively broad range of actors appears to relevant.

On the national level, the Ministry of Environment and Forestry is the central actor as regards air pollution (e.g. by setting threshold limit values for emissions), climate change and the loss of biodiversity. For instance, in the realms of water pollution and waste generation, the MoEF takes on complementary roles together with other ministries. Given that the transport sector contributes to air pollution and climate change in the Southeast Asian country, the Ministry of Transport together with other Ministries relevant for transport planning (BAPPENAS, MPWH) should be taken into account. The Ministry of Energy and Natural Resources can contribute to facilitate air quality and mitigate climate change through energy-related policy instruments and planning. For certain water issues (e.g. groundwater drills) it remains also responsible. The role of the Ministry of National Development Planning is significant in various environmental challenges including climate change, biodiversity or air pollution, largely because of the ministry’s overall planning functions. In the fields of land sealing and soil degradation, water and waste generation, the Ministry of Public Works and Housing takes on responsibilities. The Ministry of Health regulates drinking water standards and monitors drinking water quality.

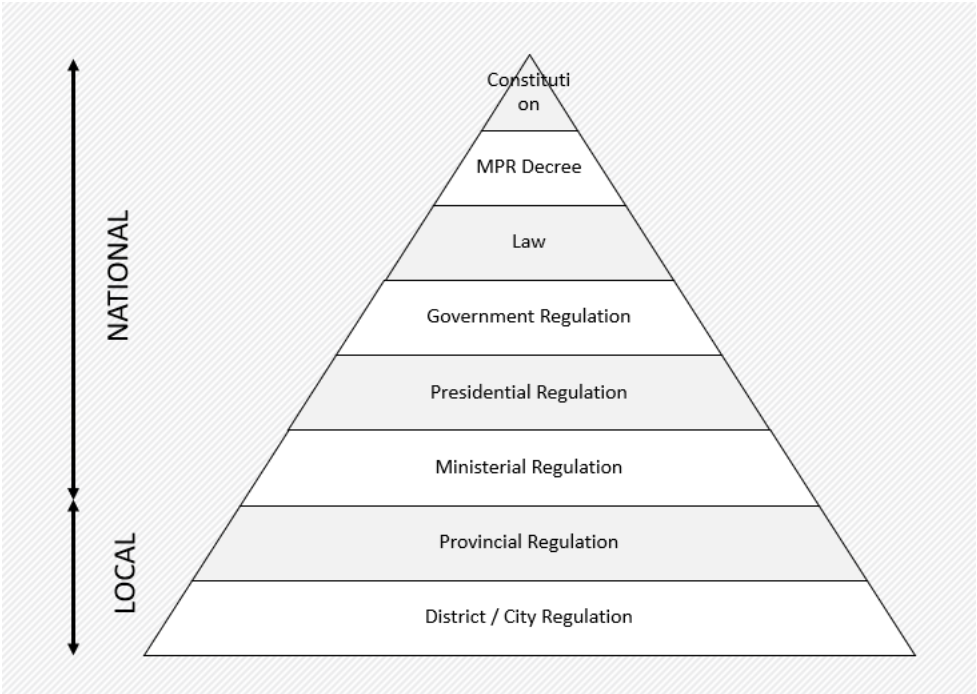
The provincial level may introduce more ambitious emission limit values and green building standards, which can facilitate clean air and mitigate climate change. On the sub-national but cross-provincial level in Java, the reporting of pollution of shallow groundwater is carried out by the Java Water Resources Strategic Study. Municipalities in turn are in charge of district spatial planning through which various environmental challenges can be tackled including air pollution, climate change, land sealing and land subsidence.

Figure 11: Indonesian authorities in the field or urban environmental protection

Source: Own illustration, Wuppertal Institute

Figure 12 illustrates the juristic authority of policies in Indonesia in general, highlighting the division between national and local policies (including the regional and municipal level).

Figure 12: Hierarchy of Juristic Authority in Indonesia



Source: Own compilation based on EP&T and DIM 2017. Wuppertal Institute

The following Table breaks down the coordinating ministries mentioned above and their attached ministries relevant for urban environmental protection.

Table 17: Coordinating ministries and their subordinate ministries with responsibilities for environmental protection in Indonesia

Coordinating ministry	Attached ministry
Political, Legal, and Security Affairs	
Economic Affairs	Ministry of Environment and Forestry Ministry of Public Works and Housing
Maritime Affairs and Natural Resources	Ministry of Energy and Natural Resources Ministry of Transportation
Human Development	Ministry of Health
(Independent ministries)	Ministry of National Development Planning

Source: Own compilation based on literature analysis, Wuppertal Institute

Based on the above sections, the following table summarises the national policies that aim to tackle environmental challenges at the urban level, as well as their status and ambition. The priority assessment in the right-hand side column is an own assessment based on the criteria as outline in the Methodology section.

Table 18: National policy implementation regarding urban environmental challenges in Indonesia

Challenge	Policies	Status and ambition	Priority
Air pollution	National Ambient Air Quality Standard	Implemented; less ambitious than WHO standards (ADB 2010).	Low to medium
	Emission vehicle standards (Decree No.4/2009, Decree No. 10/2012)	Euro 2 implemented, Euro 4 implemented by Sept 2018; slow setting of ambitious standards compared to neighbouring countries (LoC 2017).	
	Emission Quality Standards; Decree No. 13/1995	Air emission standards for iron and stell, cement, pulp and paper, steam power plants and large industries were introduced. Emission control management is obligatory for operators (UNEP 2015).	
	Emission Monitoring; Regulation No. 21/2008	Establishing Emission Standards for Thermal Power Generation Activities requiring thermal power plants to install a system for emission monitoring and develop an emission inventory (UNEP 2015).	
	Fiscal incentives regarding gasoline and diesel consumption	In 2014, the government first increased prices for gasoline and diesel; then removed gasoline subsidies and introduced a fixed price subsidy for diesel (IISD 2020).	
	Standard Pollution Index	Implemented and offered as a tool to municipalities; as of 2016 realised by 19 municipalities only (Indonesia Habitat National Team 2016).	
	NAMA SUTRI (framework	Implementation in progress; supported by	

Challenge	Policies	Status and ambition	Priority
	programme for policy development, pilot projects, capacity enhancement)	international assistance with the ambitious goal to i.e. a „coherent national urban transport policy“ (NAMA Facility 2017).	
	Waste Management Act 18/2008	Implemented; highly ambitious targets (e.g. closure of open waste dumps) but implementation behind schedule.	
Climate change and its effects	National action plan on GHG emissions reduction	Implementation in progress; binding targets for 2025 and 2050, but emission reductions are supposed to be realised largely from the forestry, while „[p]lanned [power] capacity additions for both gas and renewables have been slashed in favour of coal“ (CAT 2018).	Medium
	National Action Plan on Climate Change Adaptation (RAN-API) (e.g. mapping of regional vulnerabilities; strengthening institutional capacity; promulgation of climate change sensitive policies and regulations by 2020)	Implementation in progress; important input for overall planning but no legal basis.	
	National building code	Implemented; failed enforcement (GBPN n.d.); Jakarta green building code (Governor Decree 38/2012) appears to be ambitious at a local level.	
	National Energy Policy targets; amongst others Presidential Regulation No. 5/2006	Implemented; contribution of fossil oil as source of energy shall be reduced from 52percent in 2003 to 26.2 percent by 2025 (Urbanemissions 2017); expansion of renewables (beginning mostly after 2020) is preceded by the construction of new coal power stations (CAT 2018).	
	Act No. 30/2007; energy management	Implemented, establishing National Energy Council; energy management based on principles of sustainability, environmental protection and others (Urbanemissions 2017).	
	Energy Management Regulation No. 14/2012	Implemented; entered into force on the publication day; aims to improve energy efficiency and reduce energy consumption; sets limit for energy consumption above which businesses have to have energy management plan in place	
	Mandatory Energy Conservation of Government Office Buildings (No. 10/2005)	Implemented; ambitious as government agencies and regional governments are mandated to realise energy saving measures according to guidelines on energy saving in government buildings.	

Challenge	Policies	Status and ambition	Priority
Water pollution and availability	Acceleration of Sanitation Development in Human Settlements (national programme)	Implementation in progress (second phase); and more than 465 cities implemented a city sanitation strategy (Blackett et al. 2017).	High
	100-0-100-targets	Implementation in progress; ambitious (World Bank 2016) and aligned with National Medium-Term Development Plan	
	Regulation on the Management of Rainwater on Buildings and their plots on land No. 11/PRT/M/2014	Implemented; cross-sectoral, regulating water drainage in buildings; avoiding additional energy needs for pumping water	
Loss of biodiversity and natural landscape destruction	Biodiversity Strategy and Action Plan	Implementation in progress; aligned with national development planning, even though the status of biodiversity is threatened (CBD n.d.)	Medium
	Regulation of Minister of Home Affairs No. 1/2007 on Green Open Space in Cities	Implemented, pointing to the need for green open space in cities to encourage ecological, social, cultural and economic benefits and esthetics	
Land sealing and soil degradation	Spatial Planning Law 26/2007	Implemented; ambitious targets for green space yet implementation is difficult.	Low
Land subsidence	Jakarta Coastal Defence Strategy	Implemented/Finalised (Jakarta only)	High
Waste generation and management	Waste Management Act (No. 18/2008)	Implemented; highly ambitious targets (e.g. closure of open waste dumps) but implementation behind schedule.	Medium

Source: Own compilation and own priority assessment based on literature analysis, Wuppertal Institute

16 Summary of national challenges and priorities

This chapter summarises the significance of various fields of activities in urban environmental protection in the countries that were analysed previously. The focus of the first six subsections (one per country) will be on the definition and identification of both national challenges and political priorities as well as their correlation. Political priorities and targets will be allocated to one of the following four categories:

- The country identifies and defines the field of activity as a challenge and integrates it into its political agenda [category 1]
- The country identifies and defines the field of activity as a challenge but does not integrate it into its political agenda [category 2]
- The country does not identify and define the field of activity as a challenge; however, it is part of the political agenda and mitigation measures are implemented [category 3]
- The government neither identifies the field of activity as a challenge nor integrates it into its political agenda [category 4]

Each country will be assessed with regards to these four categories and classified within a range of significance with regard to the urban environmental challenges (very significant, significant, neither significant nor insignificant, insignificant, very insignificant) and within another range of significance with regard to the political priorities (significant, neither significant nor insignificant, insignificant).

The last subsection (16.7) will carry out a cross-comparison of countries, including the information provided in the previous subsections (16.1-16.6).

16.1 Brazil

Social inclusion, climate change mitigation, land sealing and soil degradation, air pollution, waste management and sustainable mobility are identified and defined as significant environmental challenges in Brazil. To a slightly less extent, public health and water pollution are also identified as significant challenges. The adaption to climate change, in contrast, and the loss of biodiversity are perceived as very insignificant environmental challenges.

The following fields of activity are substantially integrated and prioritized politically: Climate change mitigation, air pollution and sustainable mobility. Neither significantly nor insignificantly represented in the political agenda are land sealing and soil degradation, waste management, public health, water pollution and the loss of biodiversity. The fields participative planning and public health are not integrated at all into the political agenda.

Under category 1 fall fields where both applies: Environmental challenges are identified and integrated into the political agenda. This includes climate change mitigation, land sealing and soil degradation, air pollution and sustainable mobility, the loss of biodiversity waste management, public health and water pollution. However, the significance of political measures varies across these fields. The importance of land sealing and soil degradation (including deforestation), waste management, water pollution and public health are substantially downgraded in their significance when it comes to their political implementation. An explanation for downgrading the significance of deforestation compared to its identification as a challenge lies in recent trends in Brazil, that indicate a political turning point, including for instance budget cuts.

Category 2,3 and 4 do not include any fields.

For the fields social inclusion and participative planning only partial information is available. For the fields of activity including resilience, smart city, noise reduction, resource protection and urban mining no information is available; hence, they cannot be classified to any of the four categories.

For most fields, the identification of environmental challenges leads to the introduction of (non)binding political targets. Despite of this positive trend, however, there is no uniform trend in the significance of Brazil´s fields of activities with regard to their identification, definition and political implementation. Whereas climate change mitigation, air pollution and sustainable mobility are significantly identified as well as implemented, there are also other fields, such as waste management, where the identification as environmental challenge is substantially stronger than the actual political implementation. The latter might be attributed to Brazil´s recent economic and political crisis.

16.2 Russia

Climate change mitigation, air and water pollution, land sealing and soil degradation, waste generation, urban green spaces and spatial planning as well as the loss of biodiversity represent the most prominent themes in the context of urban environmental protection in Russia. Whereas air pollution and waste generation are defined as a very significant environmental challenges, land sealing and soil degradation, water pollution and green public spaces and the loss of biodiversity are slightly less significant. Climate change and its effects is neither significant nor insignificant. Noise pollution is categorized as an environmental challenge of low - and to some extent of very low significance.

Russia prioritizes and integrates substantially air pollution, sustainable mobility, waste management, public health and water pollution into its political agenda. Climate change mitigation and adaption as well as green public spaces are neither significant nor insignificant political priorities. Land sealing and soil degradation, noise reduction, environmental justice and the loss of biodiversity are absent from the political landscape.

Category 1, under which countries identify and define fields of activity as a challenge and integrate them into their political agenda, includes climate change mitigation, air pollution, waste management, green public space and water pollution.

Land sealing and soil degradation as well as the loss of biodiversity can be assigned to the second category. Although they are identified as environmental challenges, no political measures were integrated into the political agenda.

There are no fields that fall into the third category, under which a country does not identify fields of activities, but implements, nevertheless, measures into its political agenda. The fourth category includes noise reduction. It is neither identified as a significant field of activity, nor does it represent a political priority.

For some fields, such as participative planning, social inclusion and housing policy, no information is available at all; for others, such as sustainable mobility, climate change adaption or environmental justice, only partial information is available. Thus, it is not possible to assign them explicitly to one of the four categories.

Concluding, for some fields, the definition of environmental challenges diverges substantially from their political implementation (e.g. loss of biodiversity, land sealing and soil degradation), for others, such as air pollution and waste management, the significance of the identification of the challenges coincides with the significance of political measures.

16.3 India

In the context of a rapidly increasing population, air and water pollution, climate change mitigation as well as waste generation, public health and water pollution are defined as very significant environmental challenges in India. Land sealing and land degradation as well as climate change adaption represent also significant challenges, while noise reduction is neither considered significant nor insignificant.

India prioritizes the fields of climate change mitigation and adaption as well as sustainable mobility in its political agenda. To some lesser extent and neither significantly nor insignificantly due to non-binding targets, it integrates air and water pollution, noise reduction, and waste management.

Category 1 includes the fields climate change mitigation and adaption, air pollution, noise reduction, waste management and water pollution.

Category 2 consists of land sealing and soil degradation, which is identified and defined as a challenge, but not integrated into the political agenda.

Category 3 and 4 include none of the 18 activities listed in table 19.

Some fields, such as housing and housing policy, India´s smart city approach, sustainable mobility as well as public health, could not be classified due to partially missing information for either the definition of challenges or the implementation of political measures.

In general, it can be concluded that for some fields of activity, India shows a positive trend of identifying urban environmental challenges as well as achieving their implementation; for others India does not traverse the identification phase and hence, does not introduce binding targets into its political agenda.

16.4 China

China perceives climate change mitigation and adaption, air and water pollution as well as waste generation as very significant urban environmental challenges. Land sealing and soil degradation/pollution and public health are also significant.

For all fields, identified as environmental problems in cities, China introduced binding targets into its political agenda.

Therefore, the majority of fields (namely climate change mitigation and adaption, land sealing and soil degradation, air pollution, waste management, public health and water pollution) can be assigned to category 1.

The loss of biodiversity in turn can be classified under category 3 since political measures are introduced but the field itself is not perceived as an environmental challenge. An example for these measures to support a biodiverse ecological system at the city-level in China are national urban wetland parks that are created across the country, aiming at enhancing capacity of conserving and managing wetlands and wetland species in cities.

For public health and green public space only partial information is available. Therefore, both fields cannot be assigned to any of the four categories.

In general, China shows a positive trend in implementing policies with regards to its urban environmental agenda. Albeit it does not identify all fields as significant challenges (e.g. loss of biodiversity), it introduces binding targets for all of them (except green public space).

16.5 South Africa

Climate change mitigation, air pollution, resource protection and urban mining, water pollution and waste generation are identified as highly significant environmental challenges in South Africa. These entails, as a consequence, negative impacts on public health, which is therefore also highlighted as a highly significant field of activity in Table 19. To a slightly lesser extent, the loss of biodiversity and land sealing and soil degradation/pollution represent significant fields of activity in urban environmental protection. The aforementioned fields entail negative consequences with regards to South Africa´s economy and society. For instance, South Africa faces high public expenses on health issues and therefore economic losses. Furthermore, particularly the phenomena of desertification and land degradation as well as the loss of biodiversity negatively impact the employment situation of South Africa (e.g. fishery industry) as well as its poverty rate.

South Africa introduced binding targets for the fields of climate mitigation, air pollution, sustainable mobility, public health as well as water pollution. Non-binding targets were introduced for biodiversity loss, waste management as well as land sealing and soil degradation.

Hence, the following classifications can be made: To category 1, under which both challenges are identified and binding targets are introduced into the political agenda, the fields of climate change mitigation, land sealing and soil degradation, air pollution, waste management, public health, water pollution and to some extent the loss of biodiversity can be attributed. However, as already mentioned, the political targets for waste management, land sealing and soil degradation as well as for the loss of biodiversity are non-binding and for the latter almost non-existent. The loss of biodiversity could, therefore, also be assigned to category 2, where challenges are identified but no explicit political targets are introduced.

For sustainable mobility, resilience as well as resource protection and urban mining only partial information is available which is the reason why these fields could not be categorized.

Generally, a positive trend for South Africa can be observed with regards to the identification of urban environmental challenges (e.g. through the high number of highly significant perceived challenges) and the introduction of (non-)binding political targets.

16.6 Indonesia

Indonesia identifies climate change mitigation, air pollution, sustainable mobility, waste generation and water pollution as most significant challenges. Land sealing and soil degradation, resource protection and urban mining as well as green public spaces are neither defined as significant nor as insignificant environmental challenges. Also, the economic impact stemming from various environmental challenges (classified under resilience) is neither perceived as a significant nor as an insignificant field of activity by the Indonesian government. Finally, the environmental challenge of noise reduction is completely neglected.

With regards to the definition of political targets, Indonesia introduced binding targets for the fields of activity of water pollution and green public space. Nonbinding targets were introduced for the fields housing policy, climate change mitigation and adaption, air pollution, waste management and conservation and protection of biodiversity. Land sealing and soil degradation, noise reduction and to some extent also air pollution are fields that are not at all integrated into the political discourse.

Based on the previous two paragraphs, the following categorizations can be done: Under category one the fields of climate change mitigation, to some extent air pollution, waste management, water pollution and green public space are assigned.

The fields of land sealing and soil degradation and to some extent air pollution can be classified under category 2, where despite of the identification of the environmental challenge, neither binding nor nonbinding targets are politically defined.

There are no fields that can be assigned to category 3. However, noise reduction is neither identified as a challenge, nor are political targets defined. Hence, noise reduction is assigned to category 4.

For the fields housing and housing policy, resilience, sustainable mobility as well as resource protection and urban mining only partial information is available. Thus, these fields could not be classified into the four categories of interest.

To conclude, there is no clear trend in Indonesia´s strategy of identifying urban environmental challenges and consequently introducing (non)binding political targets. Whereas some fields could be classified to category 1, others were assigned to category 2 and 4. Also, the significance of political targets diverges for various fields of activities (e.g. climate change is perceived as highly significant challenge, but only nonbinding targets are introduced).

16.7 Summary

Having compared the different fields of activity within each country of interest in the previous paragraphs, this section carries out a cross-comparison of the main trends in terms of the four categories relevant for the respective country.

Brazil, China and South Africa are characterized by an overall positive trend of identifying urban environmental challenges as well as introducing (non)binding political targets, although the degree of significance of political priorities may substantially differ from what is actually perceived as a challenge. Whereas Brazil for instance introduced many nonbinding targets into its political agenda, the majority of China´s political priority is of binding nature.

Russia, India and Indonesia show no clear trend in identifying urban environmental challenges and prioritizing these fields of activity politically. Moreover, the level of significance of the perception of challenges coincides with the degree of political prioritization for some fields of activities, for others it diverges from the significance of political targets.

A general trend for all six countries being analysed is that the majority of fields of activity, for which information is available for both the identification of challenges and definition of political targets, falls under category 1. However, although the countries identify these fields as being environmentally significant challenges, their priority in the political agenda is, in the majority of fields, levelled down.

Finally, noise reduction appears to be a problem that is characterized by predominantly negative trend. Among the six countries analysed, noise reduction is never classified as a highly significant field, nor are binding targets introduced. It represents, therefore, a field of activity where substantially more can be done. Moreover, land sealing and soil degradation have very low political priority among three out of the six countries being analysed. Although they are identified as being environmentally significant challenges, their political implementation is often neglected.

Table 19: Fields of activity in urban environmental protection

Field of activity	Brazil		Russia		India		China		S. Africa		Indones.	
	Ch	PP	Ch	PP	Ch	PP	Ch	PP	Ch	PP	Ch	PP

Field of activity	Brazil		Russia		India		China		S. Africa		Indones.	
	Ch	PP	Ch	PP	Ch	PP	Ch	PP	Ch	PP	Ch	PP
Participative planning			l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.
Social inclusion		l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.
Housing and housing policy	l.e.	l.e.	l.e.	l.e.	l.e.		l.e.	l.e.	l.e.	l.e.		
Climate change mitigation												
Resilience	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.		l.e.		l.e.
Smart City	l.e.	l.e.	l.e.	l.e.	l.e.		l.e.	l.e.	l.e.	l.e.	l.e.	l.e.
Land sealing and soil degradation												
Air pollution												
Noise reduction	l.e.	l.e.					l.e.	l.e.	l.e.	l.e.		
Sustainable mobility							l.e.	l.e.				l.e.
Adaptation to climate change	l.e.	l.e.							l.e.	l.e.		
Resource protection, urban mining	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.		l.e.		l.e.
Waste management												
Public health			l.e.			l.e.		l.e.			l.e.	l.e.
Water pollution												
Green public space	l.e.	l.e.			l.e.	l.e.			l.e.	l.e.		
Environmental justice			l.e.		l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.	l.e.
Loss of Biodiversity					l.e.	l.e.						

Source: Own analysis, Wuppertal Institute;

Ch: National challenges to protect the environment at the urban level: =very significant; =significant; = neither significant nor insignificant; = insignificant; = very insignificant l.e.= less elaborated

PP: National political priorities to protect the environment at the urban level: =high; = neither high nor low; = low; l.e.=less elaborated

17 Case Study: Belo Horizonte, Brazil

Belo Horizonte, one of the cities located in the south-eastern region of Brazil together with Sao Paulo and Rio de Janeiro, is the capital of the state of Minas Gerais, the 6th most populous city and centre of the 3rd largest metropolitan area in the country. Belo Horizonte has a population of over 2.5 million, with 5.7 million in the Metropolitan Region of Belo Horizonte (RMBH for its Portuguese acronym), which is composed of 34 municipalities (IBGE, 2019). In 2010, Belo Horizonte's population density was 7,167 hab/km2 (IBGE, 2019).

Belo Horizonte is the city with the highest GDP in the State of Minas Gerais and the forth in the country after Sao Paulo, Rio de Janeiro and Brasilia (IBGE, 2019). The GDP in Belo Horizonte is distributed in the following manner: 70% services, 15% industry and 11% admin and 0% agriculture, while Minas Gerais has 72% services, 23% industry and 6% agriculture.

The RMBH is one of the richest Brazilian regions in mineral resources and is responsible for 66% of the mining activity in the state of Minas Gerais, especially with regard to the extraction of iron ore, manganese, gold and limestone (Gouveia, Junger, Lins, & Freitas, 2018).

Moreover, Minas Gerais hosts the second largest concentration of companies in the Information and Communication Technology (ICT) sector of Brazil. The state has Technological Parks, Industrial Districts and Technological Industrial Condominiums, with more than 6 thousand companies that mobilise around BRL 2.5 billion a year (Minas Guide, 2018).

Furthermore, the state is the second largest automotive pole in Brazil, with Fiat Chrysler Automobiles (FCA) as one of the main players. The factory is located in Betim, one the municipalities that conforms the RMBH, where hundreds of auto parts companies serve the Italian automotive company, localised in Brazil since the mid-1970s. The industrial unit of FCA in Brazil is the largest manufacturing plant of the group in the world and has an annual production capacity of 800 thousand vehicles.

The federative political-administrative organization of Brazil comprises the Union, 26 States and 5,570 municipalities, all autonomous under the terms of the Constitution. Each state dictates its own constitution and is governed by a governor. The executive body of the municipalities is the City Hall, and the legislative body is the City Council. Mayors and governors have terms of 4 years with the possibility of being re-elected once (CEPAL, 2019).

Belo Horizonte has a series of plans (Master Plan, PlanMob-BH, Belo Horizonte – a Smart City, Strategic Plan BH 2030, Greenhouse Gas Emission Reduction Plan – PREGEE, etc.), laws (e.g. the Environmental Law) and policies in place that are reviewed and monitored on a regular basis to help guide the sustainable urban development of the city. The city has already made important progress towards sustainability and in the medium and long run Belo Horizonte envisions becoming an example of smart and sustainable urban development for Brazil and Latin America. In the process of institutionalizing climate change policies, Belo Horizonte set the goal of reducing 20% of GHG emissions by 2030 in comparison to 2007.

17.1 Urban environmental protection challenges

Founded in 1897 during a period of great transformations in Brazilian history, Belo Horizonte was the first planned city of the country. It was built to be the new capital of Minas Gerais and the centre of political, cultural and commercial activities of the State, in line with contemporary development. It was neither planned as an industrial pole, nor as a metropolis of regional and national importance. However, the circumstances changed over time, turning BH and its metropolitan region into one of the most important economic agglomerations of Brazil. The

factors that influenced and reinforce this process were the government policies for the industrialization of the State; the central location of the municipality in the State, which holds extraordinary mineral reserves, as well as the related value chain; and the creation of infrastructure in the region adopted by the state and federal governments, from the 1960s and 1970s onwards (Prefeitura BH, 2016).

From the 1950s until today, the population of Belo Horizonte passed from 350,000 to 2.5 million inhabitants, i.e. it grew 7 times. At the same time, BH concentrates almost 50% of RMBH's population with a density similar to the one of Sao Paulo (7,500 habitants/km2) and higher than the one of Rio de Janeiro (5,400 habitants/km2) (Prefeitura BH, 2016), which is relatively high when compared to the RMBH with 548 habitants/km2. In those 70 years of urban sprawl and population growth, the environmental stress in Belo Horizonte and its metropolitan region increased exponentially due to the widened avenues, the channelled waterways, the polluted lakes, among others (Campos, 2017).

Air pollution

The urban fleet of Belo Horizonte has already surpassed the 1.8 million cars, i.e. 0.75 vehicles per inhabitant, one of the highest motorisation rates in the country (Campos, 2017). This rate combined with more than 100,000 companies located in the city in an area of 331,000 km2, give Belo Horizonte's air pollution the characteristic of mixed.

According to the air quality analysis report of the World Health Organization (WHO), the RMBH is among the urban areas with the most polluted air in the world, appearing in the 467th position. The study published in 2011 raised data from 1.1 thousand cities in 90 countries and pointed out that the region is on the threshold of the WHO air quality standards, with a rate of 20 micrograms of pollution per cubic meter of air (ug/m^3). Notwithstanding, the RMBH is the Brazilian metropolitan area with the lowest air pollution rate. (Gouveia et al., 2018).

Climate Change and its effects

Historically, Belo Horizonte has been affected by intense rainfall events that have impacted the population in several ways, including deaths and economic losses. Future climate trends indicate a raise in the exposure to extreme events associated with heavy rains and higher temperature levels in Belo Horizonte, increasing the risk of floods and landslides, on one hand, and the proliferation of tropical diseases and heat waves, on the other hand.

In October 2015, for instance, the flood of Avenida Vilarinho, affected hundreds of people and caused economic losses for ca. R $ 2,000,000.00, in just 40 minutes of rain. Moreover, the urbanisation model of Belo Horizonte contributes to the composition of a stressful microclimate, increasing the thermal discomfort that has been magnified by the heat waves that are estimated to increase their intensity 10 times by 2030. Finally, in relation to public health, in the past years there has been an important increase in cases of tropical diseases transmitted by mosquitos' vectors. In the case of dengue, for example, Belo Horizonte observed the number of occurrences quadrupled in the last decade (Prefeitura BH, WayCarbon, & Konrad Adenauer Stiftung, 2016).

Moreover, due to its population and economic growth in the past decade, BH's GHG emissions increased 71% between 2000 and 2013, rising from 2.59 to 4.40 million tons $CO_{2\text{-eq}}$, where the main source in 2013 was the transport sector (71%), followed by energy use in stationary units (19%) and waste and sewage treatment (11%). If this trend continues, the total emissions of the Municipality could reach 6 million tons per year by 2030 (Prefeitura BH, 2015a).

Water pollution and access to water

In Belo Horizonte, the shared management of water and sewage services, signed with the Companhia de Saneamento de Minas Gerais (Copasa-MG) in 2002, currently guarantees 100% of potable water in the capital, 90% of collection and more than 60% of sewage treatment. Secondary treatment reaches more than 70% of the collected sewage, all of which is much higher than the country's average (Prefeitura BH, 2015b). The management of water resources, however, has gained attention in recent years due to the extremely low levels of reservoirs, very low rainfall rates and the persistent high rates of water loss in distribution (Prefeitura BH, 2016).

According to data from the Institute of Water Management of Minas Gerais (Igam by its Portuguese acronym), only 33% of the rivers in Minas Gerais have good and excellent conditions. In the last survey (2016), 23% of the rivers evaluated presented bad and very bad conditions. A mixture of domestic sewage, industrial waste and trash were found in the tests run by the entity. This situation aggravates the water crisis in the State and points to the urgent need to universalise basic sanitation.

The pollution of the Lake Pampulha, the artificial lake built as a source of water for the city in the 1940s and location of some of the most important BH's landmarks, is caused by the two main waterfowl feeders in Belo Horizonte, the Sarandi and Ressaca streams. Despite the cleanness and purity of its springs, the waste from homes and industries with heavy metals, diesel oil, gasoline and asphalt dust, as well as pet bottles and dead animals, turn the lake into a polluted water body (ABES, 2013).

It is worth noting that Minas Gerais is a mining state and as such it has been subject to several environmental catastrophes generated by the mining industry, which have caused severe water pollution, loss of biodiversity in the surroundings of Belo Horizonte.

In November 2015, the foundation dam of the Samarco Mining Company in the municipality of Bento Rodrigues, located in the central region of the Minas Gerais State broke, leaving 19 deaths and almost 250 affected families. The polluted water reached Río Dolce, affecting 230 municipalities from Minas Gerais and the neighbouring state Espírito Santo (Mendonça, 2016). It was then known as the largest environmental disaster in the history of Brazil. However, in January 2019 the mining company Vale SA caused an even larger environmental disaster in Minas Gerais. The dam containing wastewater from the Córrego de Feijão Mine located in the Municipality of Brumadinho (Metropolitan Region of Belo Horizonte) broke, by which 201 people died and 107 are still missing (Globo, 2019). This environmental disaster depleted 112 hectares of native forests and polluted 305 km of the river Paraopeba with a terrible impact on the fauna, flora and water supply of the 21 municipalities visited along the river (Oliveira, 2019). The mud descends slowly, but it will not stop, Ribeiro warns. This time, it affected Paraopeba, the river from which 53% of the water from the Metropolitan Region of Belo Horizonte comes. Preliminary analysis indicated that 2.6 million square meters of forest were destroyed by mud. (Azevedo, 2019).

Land degradation and deforestation

The deforestation report from the State of Minas Gerais found by comparing satellite photographs from 2007 to 2015 that 41 clearings have been opened by lumberjacks and enterprises in forest areas, devastating about 380 hectares of the Serra do Gandarela National Park and the Serra da Pedreira Environmental Preservation Area. The federal environmental reserves near Belo Horizonte are being permanently cut down to create pastures, plant eucalyptus or make charcoal by farmers and foresters in the bordering parcels and inside the mentioned national parks (Parreiras, 2015).

Waste generation and management

In Belo Horizonte, 2,800 tons of waste are collected daily by the municipal collection service, which has a coverage of 96% of the households in formal settlements and 72% in informal settlements. However, only 122 tons, i.e. 4.4%, of the waste are recycled. Moreover, 14% of the waste collected every year, 113,000 tons, is collected from clandestine dumpsites (Prefeitura BH, 2019b). However, it is worth noting that the Coleta Selectiva Program, which currently serves 36 neighbourhoods, i.e. a population of 390,000 inhabitants, has helped increase the share of recycled material from 1.08% to 4.4% between 2013 and 2019.

Loss of biodiversity

Despite the smaller extension when compared with the Bento Rodrigues disaster, Brumadinho's disaster has a complete different dimension: according to the experts, the affected forests and rivers were much richer and important for environmental balance. The rupture of Vale's iron ore tailings dam at Córrego do Feijão has dumped about 12 million cubic meters of mud in one of the most important environmental areas of Minas Gerais, damaging water security and biodiversity. In the area the following animal species have been identified: 25 mammals, 259 bird species, 86 fish species, several of which are endangered.

The Vale mud affected, scientists note, some of the last significant areas of Mata Atlântica and Cerrado de Minas, within the Unesco Biosphere Reserve of Serra do Espinhaço. The place is considered a wildlife refuge. From them comes the water that gives men and animals water (Azevedo, 2019).

17.2 Cross-sectoral policies and measures to protect the urban environment

Belo Horizonte has a series of plans and policies in place that are reviewed and monitored on a regular basis to help guide the urban development of the city. Belo Horizonte has already made important progress towards sustainability and in the medium and long run Belo Horizonte envisions becoming an example of smart and sustainable urban development for Brazil and Latin America.

Environmental Law of Belo Horizonte

The Environmental Law of Belo Horizonte, approved in 1985, was created with the goal of providing the necessary framework for the implementation of the Municipal Environmental Policy, aiming at the conservation and recovery of the environment, as well as the improvement of the quality of life of the population. The Municipal Environment Secretariat, the entity in charge of the implementation of this Law is responsible for the following activities (Prefeitura BH, 1985):

- The formulation of the technical norms and standards for the protection, conservation and improvement of the environment, observing the federal and the state legislations;
- The identification of priority intervention areas, relative to environmental quality;
- The control of the compliance with the norms contained in the legislation related to the protection, conservation and improvement of environment;
- Raising awareness about the need to protect, improve and conserve the environment.

Municipal Policy for Climate Change Mitigation

The Municipal Policy for Mitigation of the Effects of Climate Change was institutionalized by the City Hall of Belo Horizonte through Law 10.175/11, sanctioned in May 2011. The administration

included, in the city's strategic planning, the goal of reducing greenhouse gas emissions in the city by 20% by 2030. In order to achieve these objectives, various projects, actions and programs were defined (Prefeitura BH, 2015b).

The Greenhouse Gas Emission Reduction Plan (PREGEE) establishes urban-environmental planning oriented to the reduction and mitigation of greenhouse gases. Actions will be defined in the areas of transport, energy, sustainable construction, land use, health and education that favour sustainable development and enable the achievement of national climate goals and the promotion of a low carbon economy (Prefeitura BH, 2015b).

The Municipal Council of the Environment (Comam) approved on November 2017, the resource for contracting the preparation of the Municipal Plan for Adaptation and Resilience of BH will be financed by the Municipal Environmental Defence Fund (FMDA). R $ 150 thousand will be made available. The Municipal Plan for Adaptation and Resilience of BH will continue the Vulnerability Study on Climate Change prepared by the Municipal Secretariat for the Environment (SMMA). The objective is to promote the reduction of impacts to climate change and to manage the risk associated with this phenomenon, based on the results of the Belo Horizonte Climate Vulnerability Study: heat waves, floods, landslides and tropical diseases such as Zika and Dengue (Prefeitura BH, 2017b).

Master Plan (Plano Diretor)

The Master Plan is the basic instrument of the urban policy of the municipality and contains the principles that guide the planning and management of the city.

The Master Plan is the basic instrument of the Urban Policy of the municipality and defines the fundamental norms of city planning for the fulfilment of the social function of the property. It contemplates issues related to urban structure and development, the environment, social housing, historical and cultural heritage, mobility, as well as the treatment and relationship of public and private spaces. The Master Plan of Belo Horizonte, in force since 1997, has already been subject to two revisions (in 2000 and 2010), as well as the Law on Land Use, Land Use and Land Use, Law No. 7.166/96.

The new Master plan under discussion has the following priorities:

- To guide the sustainable growth of the city, promoting densification along the main corridors and centralities, yet respecting the capacity of each area.
- Recover the public investments made in the city and transform them into improvements for all.
- Ensure affordable housing in areas with good infrastructure and location.
- Democratize and humanise public space
- Improve environmental quality, with adequate use of natural resources and balance between preservation areas and urban soil.
- Preserve and restore cultural heritage
- Improve urban mobility through: (i) prioritize and qualify public and non-motorized transportation and reduce incentives for individual transportation; (ii) integrate the various means of transportation and promote a more intense occupation along the main mass transit axes; and (iii) promote new centralities to reduce commuting needs and distances.

Moreover, the new Master Plan aims at simplify the content for easy understanding and application of land use zones and its mechanisms. It also includes the SDGs and the New Urban Agenda (NUA) (Prefeitura BH, 2019a).

Strategic Plan BH 2030 (Plano Estratégico BH 2030)

Created at the end of 2009 with the collaboration of several experts, sociologists and community leaders, the BH 2030 Strategic Plan seeks to project an ideal, sustainable city and opportunities for its inhabitants in the coming decades, as well as seeking more efficient ways to control public spending, combining effectiveness and quality (OPS, 2017).

In the reviewed version of 2016, the BH 2030 Strategic Plan defines 43 goals that the city will have to achieve to ensure sustainability, quality of life and opportunities to its residents until 2030. The new plan reviews the 25 targets set in 2009 and adds other challenges. In the balance are advances and achievements in education, health, urban planning and security, but also frustrations in priority areas such as housing and transportation (Lopes, 2016).

Two dimensions with direct environmental implications are considered in the Plan: 1) a compact and polycentric urban structure with adequate regulations and services connected through high-quality public transport and non-motorised infrastructure, and 2) a resilient and sustainable city (Prefeitura BH, 2016).

Strategic Programme Belo Horizonte, a Smart City

As a consequence of the favourable technological environment of Belo Horizonte, in 2018 the municipality launched the Strategic Programme "Belo Horizonte – a Smart City". As a matter of fact, Belo Horizonte has the highest density of information technology companies in Brazil: 331/100 thousand inhabitants. There are more than 250 start-ups in the San Pedro Valley (Brazil's largest start-ups community). Its Technological Park, BH-Tec, one of the largest in the country, hosts important research and development companies. In addition, Belo Horizonte is a knowledge hub, as it comprises 62 universities. Thus, this plan involves the sustainable use of the city's resources, such as water and energy, waste management, traffic improvements, integration between public systems and efficient citizen services through the use of technology, innovation and information systems (Prefeitura BH, 2018a).

Table 20 provides an overview of cross-sectoral, integrated policies of the Belo Horizonte. Interestingly, all plans and policies are somehow interlinked and have been institutionalised over the years. Thus, several of the mentioned plans and policies have not been replaced, but updated to the new circumstances independently of the political agenda of the governing authority.

Table 20: Cross-sectoral policies in Belo Horizonte and their relation to activities in urban environmental protection

Cross-sectoral Policies	Air quality	Climate Change	Water management	Waste management	Biodiversity
Environmental Law	x	X	x	x	x
Master Plan	x	X			
Belo Horizonte, a smart city	x	X	x	x	
Strategic Plan BH 2030	x	X	x	x	x
Municipal Policy for Climate Change Mitigation	x	X	x	x	x

Cross-sectoral Policies	Air quality	Climate Change	Water management	Waste management	Biodiversity
Greenhouse Gas Emission Reduction Plan – PREGEE	x	X		x	x

Source: Prefeitura BH, own compilation, Wuppertal Institute

Sectoral Strategies, policies and programmes

The city also stipulated a number of sectorial policies, strategies and programmes that are presented in this section.

Air Pollution

The initiatives for the preservation of air quality in Belo Horizonte have a highlight in the Oxygen Operation Programme, created in 1988 in an agreement of the City Hall of Belo Horizonte with the Government of the State of Minas Gerais. Its objective is to control the emission of smog emitted by motor vehicles powered by diesel oil.

The Oxygen Operation Program is strictly aligned with the technical and legal advances established by the National Environmental Council (Conama) through the National Program for the Control of Pollution by Motor Vehicles (Proconve) (Prefeitura BH, 2015b).

Transport

With regard to mobility, Belo Horizonte has an innovative Sustainable Urban Mobility Plan, called PlanMob-BH, with comprehensive measures including a Transit-Oriented Development Strategy, the extension of BRT corridors and the provision cycling solutions and infrastructure. By 2030, the plan expects that the measures implemented contribute to reductions of 36% in GHG emissions, 25% in travel time and 19% in transport costs (Secretaria Municipal de Governo BH, 2013). A process of review and adjustment of the plan started in 2016 and was approved in 2017. The plan contains the following 8 intervention areas:

- Active mobility
- Public transport
- Calming zones
- Private vehicles
- Logistics
- Urban sustainability
- Universal accessibility
- Management, control and operation

Waste Management

In 2017 the Municipality of BH launched the final version of the Municipal Plan for Integrated Management of Solid Waste of Belo Horizonte (PMGIRS-BH). PMGIRS-BH is a strategic planning instrument, for a 20-year horizon, that contains guidelines and actions for the environmentally adequate and sustainable management of solid waste. The planning includes from the generation to the final disposal of municipal solid waste, observing technical, operational, economic, social, environmental and population participation aspects. The plan also takes into

account the influences and interferences of the management of waste from the Metropolitan Region of Belo Horizonte, highlighting the border regions of the capital. The content of the document and the participatory process for its elaboration meet the requirements of Law 12.305 of 2010, which establishes the National Solid Waste Policy (Prefeitura BH, 2017a).

17.3 Overview of activities in different fields

The following sections provide a brief overview of the most important activities in different fields, taking into account the above-mentioned strategies and policies.

Air pollution

An important advance in the monitoring and environmental management of the Municipality has been the installation and operation of Air Quality Monitoring Stations, which has allowed the Municipality of Belo Horizonte to develop indicators and studies that, in addition to informing citizens fast and accurately about the daily levels of pollution, contributes to the definition of policies to control and improve the air quality in the city. Daily and continuous monitoring is carried out through the inspection of vehicles on roads, end points and at bus stations.

Moreover, a series of low-carbon mobility measures have been implemented so far under the framework of the PlanMob-BH with significant impacts on air pollution. Some of these measures are:

- Belo Horizonte bike sharing system, called Bike-BH, is already in place with 40 stations and 400 bikes and 10.000 registered users.
- 2 BRT corridors were launched in 2014.
- Belo Horizonte already pedestrianized 2 streets in the downtown area. The new infrastructure also includes bicycle lanes and a terminal of BRT MOVE.
- Belo Horizonte implemented its first Zone 30 in the Cachoeirinha neighbourhood, an area where the conflict between pedestrians and motor vehicles is critical because of the width of the road, the lack of signage for vehicles, the very narrow sidewalks and the intense flow of children and adolescents due to the existence of two large schools in the area. This is the first of a series of planned interventions to be implemented in approximately 25 blocks.

As a result, Belo Horizonte is the Brazilian state capital with the best air quality. The World Health Organization (WHO) establishes a limit of 20 micrograms per cubic meter of air for pollution levels as an annual average of safety. According to a study released in 2011 by the organization, Belo Horizonte is the only metropolis in Brazil, among those analysed, to meet the standard established by the organization. Data from the 2008-2011 period were considered for 1,100 cities in 91 countries and the capital of Minas Gerais appears in the 615th position in the overall ranking of the study, the best position in the country (Prefeitura BH, 2015b).

Buildings

The *Sustainable BH* Certificate is granted by the municipality to public and private enterprises, residential and commercial and/or industrial sites that adopt measures that contribute to the reduction of water consumption, energy, direct emissions of greenhouse gases and the reduction/recycling of solid waste.

The participation in the Program is voluntary and the certified enterprises receive the Gold, Silver or Bronze Label, depending on the scope of the project and the results achieved. A Good Environmental Practices Certificate is also granted to those projects, which adopt sustainability

measures, but do not reach the minimum requirements of each thematic area (Prefeitura BH, 2015b).

Energy

Minas Gerais is the Brazilian state, which has the largest per capita area of solar collectors. There are about 1.98 million m2 of collectors, being approximately 800 thousand m2 in Belo Horizonte. The capital has water-heating systems by solar energy in about 2,600 buildings. After 25 years of studies in the implementation and diffusion of technology, Belo Horizonte is considered the "National Capital of Solar Energy" (Prefeitura BH, 2015b).

Water pollution and access to water

In recent years, Belo Horizonte has followed a long and rational path towards sustainable urban water management. The city has successful management programs such as Nascentes/Drenurbs and Propam, in addition to having recently participated in an international project on this subject, coordinated by Unesco, the Switch project. The Nascentes/Drenurbs Program is promoting the decontamination of watercourses, the reduction of flood risks, the control of sediment production, and the reduction of water pollution, as well as the integration of natural water resources into the urban setting. Three streams have been revitalized and their areas transformed into parks - the Primeiro de Maio and Nossa Senhora da Piedade, in the North region, and the Nossa Senhora da Piedade, in the North region. The goal is to revitalize and preserve watercourses, for a total of 170 kilometres, recovering the sites and creating new green areas and parks.

The program proposes the recovery and environmental development of the 97 square kilometres of the Pampulha Basin through the preservation of springs, the clean-up of waters, the improvement of sanitary conditions, and the treatment of degraded urban areas facing the risk of erosion and flooding. It serves a population of about 450,000 people and its main instrument is the Pampulha Consortium which, in addition to the companies in the region, includes the two municipalities that are part of the basin, Belo Horizonte and Contagem (Prefeitura BH, 2015b).

Waste generation and management

Over the years, Belo Horizonte has adopted a proactive approach to solid waste management. A great example of this is the Management Plan of Solid Waste from Construction Sites, which has existed since 1995, i.e. 7 years before the national resolution regulating the issue was established in 2002. Today there are three fully operational plants of the Recycling of Construction and Demolition Waste Program (RCD).

Furthermore, Coleta Seletiva is a programme that consists in the separation and collection of the waste discarded (paper, plastic, metal and glass) by homes and businesses in Belo Horizonte. The programme has two types of selective collection in place: point-to-point and door-to-door. Educational campaigns are carried out before the implementation of these two modalities in the neighbourhoods with the intention of raising awareness among citizens about the topic (Prefeitura BH, 2018b).

Other programmes related to waste collection executed by the Municipality of Belo Horizonte are: Community Agent for Urban Cleaning (ACLU), Composting Program and the Tire Collection Program. Moreover, it is worth noting that Belo Horizonte is the first state capital in the country to have restricted the use of plastic bags in commercial establishments. Municipal Law 9.529/2008 prohibits the use of any disposable plastic bag that is not compostable (made of organic material) (Prefeitura BH, 2015b).

Loss of biodiversity

INTERACT-Bio is a four-year project designed to improve the use and management of natural resources in fast-growing cities and their surrounding regions. The initiative aims to provide expanding urban populations with nature-based solutions and their respective long-term benefits.

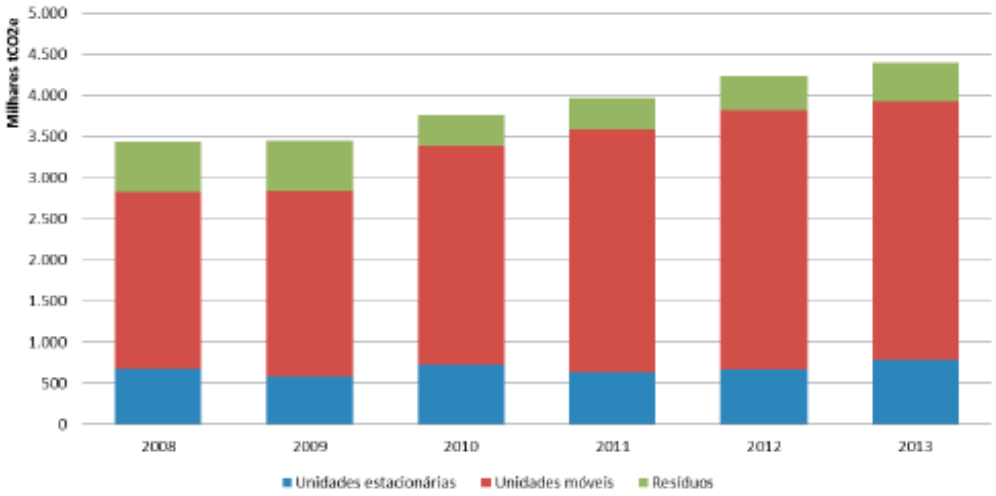
In the Metropolitan Region of Belo Horizonte, INTERACT-Bio will create, in the next three years, efforts to integrate biodiversity and ecosystem services in metropolitan planning, especially, in the integrated urban development plan, with land use management instruments and in infrastructure projects (Prefeitura BH, 2018c).

17.4 Spotlight: Climate Change Mitigation

During the first decade of this century, Belo Horizonte presented a scenario of economic and population growth, with a consequent increase in the per capita income. Due to its economic structure, the expansion of its GDP occurred mainly in the tertiary sector, that is, in the provision of services, trade and public administration. As a consequence, BH's GHG emissions increased 71% between 2000 and 2013, rising from 2.59 to 4.40 million tons $CO_{2\text{-eq}}$. This evolution can also be reflected in the emissions sources of the city, where the main source in 2013 was the transport sector (71%), followed by energy use in stationary units (19%) and waste and sewage treatment (11%) (Prefeitura BH, 2015a).

Compared to 2007, the base year for long-term reduction targets, the increase was 40%. If this trend continues, the total emissions of the Municipality could reach 6 million tons per year by 2030, a level currently observed in cities such as Paris, Seattle and Melbourne (Prefeitura BH, 2015a).

Figure 13: Evolution of GHG emissions 2008-2013 by source (stationary, mobile, waste)



Source: Prefeitura BH, 2015a

Among the main contributors to BH's emissions, the transport sector has the lion share with 71% and gasoline accounting for 59% of the total emissions. Thus, the implementation of low-carbon mobility solutions that reduce the consumption of fossil fuels in the transport sector are key to achieve the ambitious climate mitigation goal of reducing 20% of GHG emissions by 2030 in comparison to 2007 that Belo Horizonte has set. In this context, it is expected that the

implementation of the measures proposed in the Mobility Master Plan of BH (PlanMob-BH) will contribute to the emission reduction targets (Prefeitura BH, 2015a).

Over the last decade, Brazilians have increased their per capita generation of solid waste and in Belo Horizonte the situation was no different. While in the previous decade about 0.5 kg of waste per inhabitant per day was generated in Belo Horizonte, in recent years (between 2008 and 2010) the average was 1.3 kg per person per day, a typical average for industrialized nations. In addition, given the low recycling rates (less than 3%) and the disposal of most of the solid urban waste in landfills, the methane emissions tend to be relevant. New interventions leading to the use of biogas or introducing advanced thermal solid waste treatment in the Macaúbas landfill can reduce emissions in ca. 250,000 tons of $CO_{2\text{-eq}}$ per year or about 6.5% of the total emissions in 2010 (Prefeitura BH, 2015a).

Institutionalisation of Climate Change in BH's policies

In 2006, the Municipality of Belo Horizonte established the Municipal Committee of Climate Change and Eco-efficiency (CMMCE by its Portuguese acronym) with the aim of generating local mitigation and adaptation policies to address the impacts of Climate Change. The CMMCE is a collegiate and consultative body comprised of representatives of the Municipal and State Government, civil society, NGOs, private sector and academia, which has the goal of supporting the implementation of the Municipal Policy for Climate Change of the City of Belo Horizonte. It acts as liaison between public policies and private initiatives aimed at reducing emissions of effect gases greenhouse and air pollutants. Its main action areas are reducing solid waste production and greater efficiency in waste reuse and recycling processes; encouraging the use of renewable energy sources, improving energy efficiency and the rational use of energy, and raising citizens' environmental awareness (Meio Ambiente, 2018).

The CMMCE also promotes the participation of Belo Horizonte in important national and international collaborative networks, especially those focused on the actions of cities or local governments in facing climate change such as ICLEI, Carbonn Cities Climate Registry, World Bank, WWF Brazil, CDP, WRI, UN-Habitat, ITDP, GCoM, among others. Through international cooperation, a number of bilateral and multilateral partnerships are being carried out, along with international funding agencies, which contribute to the improvement and advancement of municipal climate policy (Meio Ambiente, 2018).

Furthermore, in May 2011 the Municipal Law N° 10,175 approved the Municipal Policy of Climate Change Mitigation, which has the goal of ensuring the contribution of the Municipality in aligning the local policy to the efforts of the United Nations Framework Convention on Climate Change (UNFCCC), to achieve the stabilization of GHG concentrations in the atmosphere (Prefeitura BH, 2012).

The Policy stipulates the guidelines for interventions in the following sectors (Prefeitura BH, 2012):

- Transport
- Energy
- Waste management
- Health
- Buildings
- Land Use

Monitoring

Belo Horizonte developed its first Greenhouse Gas Emissions Inventory in 2009 for the period 2000 to 2007. The Municipal Greenhouse Gas Emissions Inventory of Belo Horizonte followed the principles and approaches recommended by the IPCC 2006 Guidelines for National Greenhouse Gas Inventories", in addition to the ICLEI guidelines, and other similar standards. The methodological support and the international standardization ensured transparency and allowed the comparison to other GHG Inventories in Brazil and abroad.

The first update, in 2012, considered the period 2008 - 2011. The methodology adopted for the update differed from the original one because of the progress done in the subject in that period. Despite the small loss of comparability to the first Inventory, the new methodology presents results that are more adequate and better adapted to the municipal urban dynamics and represent better the sectors and sub-sectors responsible for GHG emissions. The second update, comprising the period from 2011 to 2013, used the same methodological framework as the first update, allowing the comparative analyses gain greater depth (Prefeitura BH, 2015a).

The 3rd update of the GHG Inventory is currently being developed and its results will be published by the end of 2019.

17.5 Spotlight: Sustainable Mobility

One of the biggest challenges and goals of Belo Horizonte is the implementation of a sustainable mobility system that combines high-quality and low-carbon public transport with the adequate infrastructure for the incremental use of non-motorised transport in the city. At the same time, Belo Horizonte's vision is to integrate land use in such way that urban sprawl, as well as commuting distances and trips are reduced, contributing not only to the reduction of GHG emissions and the improvement of air quality, but also to the enhancement of the quality of life of the citizens of Belo Horizonte. In this context, in 2010 the Municipality of Belo Horizonte elaborated the Master Plan of Sustainable Mobility of Belo Horizonte (PlanMob-BH), which sets a series of targets to be achieved until 2020, 2025 and 2030. It is worth noting that BH was the first Brazilian city to develop a sustainable mobility plan. Only in 2012, the national urban policy set the elaboration of such plans as a requirement for all Brazilian municipalities of more than 20,000 inhabitants (BHTrans, 2017).

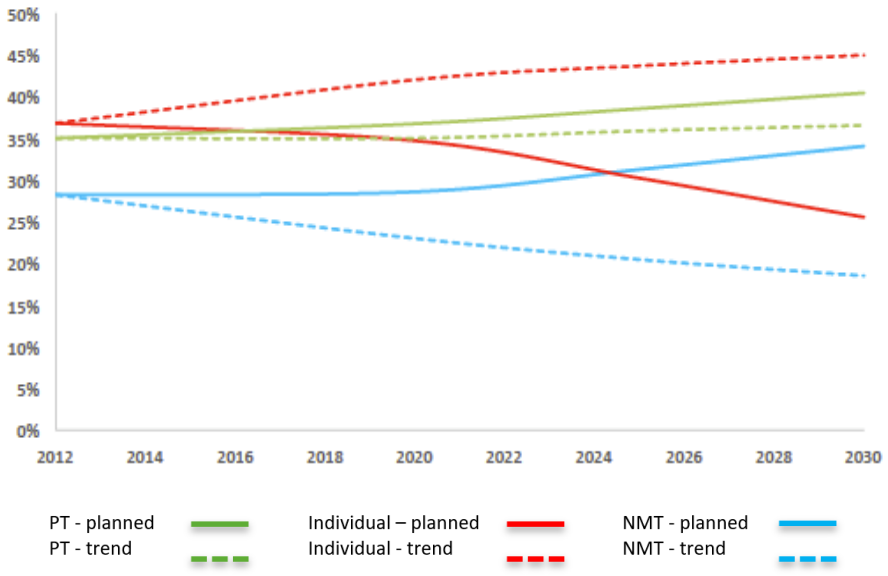
In 2013, with the aim of monitoring the progress of the policies being implemented under the framework of the PlanMob-BH, the Municipality founded the Mobility Observatory of Belo Horizonte (ObsMob-BH), which is in charge of elaborating an annual report with a summary of the 99 indicators that measure the progress towards the PlanMob-BH's targets. Then, in 2016 the PlanMob-BH was reviewed in order to assess the progress achieved towards the goals and to understand the necessary changes in the policy for its success (BHTrans, 2017).

The expected results of PlanMob-BH 2030 are summarised in the goals of its reviewed version, which have been proposed and evaluated by the ObsMob-BH, setting the corresponding targets to be achieved by 2020, 2025 and 2030. The proposed goals are (BHTrans, 2017):

- Increase the number of walking trips, by improving the comfort and safety of pedestrian infrastructure, the implementation of Zones 30, as well as the execution of educational and awareness raising campaigns.
- Increase the trips by bicycle through the construction of bike lanes, the installation of a bike sharing system, bicycle racks and its integration with other modes, as well as the execution of programs to promote the safe interaction between cyclist and other road users.

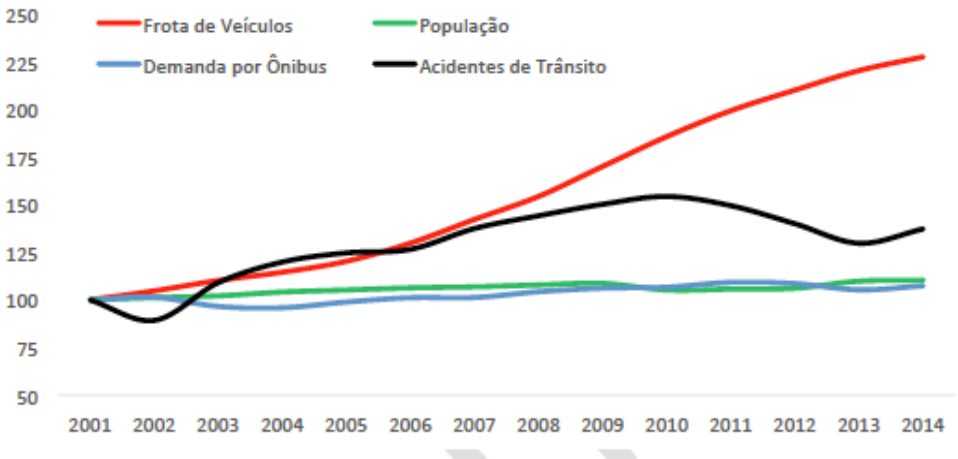
- Increase the number of trips done by public transport through its capacity expansion, physical and tariff integration, time reduction and promotion of universal accessibility and inclusion social.
- Reduction in the number of trips through the implementation of strategies for demand management, with customer service by public transport and actions of discouragement.

Figure 14: Modal share evolution 2012-2030 Plan vs. current trend



Source:BHTrans,2017

Figure 15: Evolution of the main mobility indicators 2001-2014 (fleet, population, PT demand, road accidents)



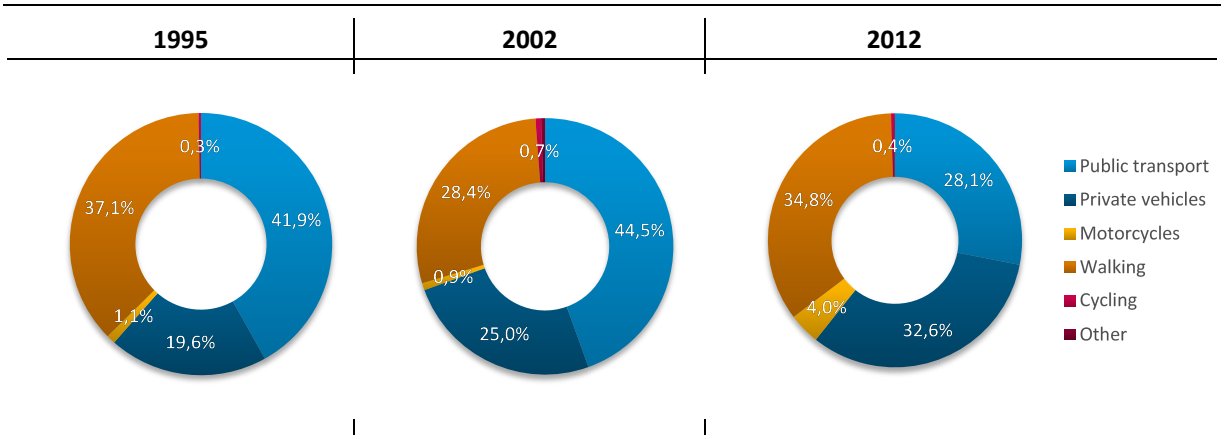
Source: BHTrans, 2017

The Baseline

In the period from 2001 to 2014, the vehicle fleet more than doubled, while the population and the demand for buses remained practically the same. The growth in the number of vehicles and trips affects directly the performance of public transportation, with an increase in travel time of

23 minutes between 2002 and 2012. However, it is worth noting that despite the higher motorisation rate, road accidents have been decreasing systematically since 2010.

Figure 16: The evolution of the modal share in Belo Horizonte 1995-2012



Source: BHTrans & ObsMob-BH, 2019

As it can be observed in Figure 16, there has been a significant increase in the use of private motorised vehicles with automobiles passing from 19.6% to 32.6%, and motorcycles from 1.1% to 4.0% between 1995 and 2012[4]. According to the annual report of 2018, the absolute values of other modes, including public transport have not changed over time, despite its percentual variation (BHTrans & ObsMob-BH, 2019).

The measures

The PlanMob-BH contains 8 intervention areas, including active mobility, public transport, calming zones, private vehicles, logistics, urban sustainability, universal accessibility, and management, control and operation. These are divided in 23 programmes and 175 measures have to be carried out until 2030 (See Figure 17). Until May 2018, 85 measures, i.e. 56% were already implemented or on going. Table 21 shows a selection of measures, allowing the reader to have an overview of the scope, the completeness and ambition of PlanMob-BH.

[4] The data presented in Figure 16 has been extracted from the corresponding Origin-Destination Survey, which is carried out once every 10 years, being the last one, the one from 2012.

Figure 17: The 8 intervention areas of the PlanMob-BH

Source: BHTrans 2018; own compilation, own illustration, Wuppertal Institute

Results

The presented information related to the short, medium, and long-term targets summarised in the PlanMob-BH is just an example of the strong commitment of the Municipality of Belo Horizonte to implement measures to promote the sustainable development of the city. As a consequence, Belo Horizonte has received several national and international sustainability prizes such as the Cities Challenge for the Planet Award granted by the WWF (4 times) and the Sustainable Transport Award granted by ITDP (2015). However, the data shows that despite the commitment, ambition and efforts of BH's municipality towards the achievement of sustainability goals, the sustainability concept has not set yet among the population.

It is so that despite the high investments in public and non-motorised transport and the improvements in the quality of the PT service and NMT infrastructure, the per capita emissions in the road transport sector increased from 0.72 to 0.94 t $CO_{2\text{-eq}}$ between 2007 and 2014. Moreover, the percentage of days with good air quality in the same period went from almost 80% to 53%, when the target set was 83%. The negative results in these two key indicators are a consequence of the unstoppable increase in the number of private vehicles and motorcycles circulating in the city. It is so that in the past decade, the fleet grew 84%, while the population growth was only 4.6%. As a consequence, the motorisation rate of Belo Horizonte is currently one of the highest in Brazil with 0.75 vehicles per inhabitant (BHTrans & ObsMob-BH, 2019).

Table 21: Summary of the most relevant measures completed or ongoing under the PlanMob-BH framework

Intervention Area	Completed / On-going measures	Targets 2020/2030
Active mobility	83 km of cycling lanes already implemented and 83 km in the procurement phase.	Target 2020: 245 km
	1,704 public parking places for bicycles	Target 2020: 5,000

	Bike sharing system (Bike BH) with 40 stations and 400 bikes and 10.000 registered users	Expansion being assessed
Public Transport	2 BRT corridors launched in 2014	Target 2020: 3 BRT corridors
	4 BRS corridors in the procurement phase	Target 2020: 4 BRS corridors
	45 km of segregated bus lanes completed, 68 km in the procurement phase	Target 2020: 133 km
Traffic calming	Implementation of the first Zone 30	Target 2020: Implementation of at least 2 Zones 30
	Temporary pedestrian streets every Sunday in 9 neighbourhoods of BH	Permanent
	Permanent road safety and awareness raising campaigns	Permanent
	Safe routes to school Programme in 63 municipal schools	Target 2020: All municipal schools participate in the Programme
Private vehicles	Implement measures and control to improve the taxi service in BH	Permanent
	Parking management for automobiles and motorcycles	Permanent
Logistics	Elaboration of a logistics plan for the RMBH – on going	2020: Implementation of the logistics plan for the RMBH
Urban sustainability	Feasibility studies of the implementation of a TOD Strategy	2020: Start the implementation of a TOD Strategy
	Feasibility study for the renewal of the bus fleet with electric buses – completed	2020: Pilot project with 25 buses financed and launched
Universal accessibility	All new projects are being built with universal design on sidewalks, crossings, access to subway stations, facilities and public spaces	Permanent

Source: (BHTrans, 2018)

The Annual Mobility Report of 2018 states that the modal shift target of reducing the share of private vehicles in 2% (from 36.6% to 34%) and maintaining the share of public transport by 43%[5] does not seem to be a likely scenario by 2020, given that the fleet increased in 25% and the number of passengers of PT decreased in 16% between 2012 and 2018. It is worth noting that despite the efforts, there are several planned projects, mostly in terms of infrastructure, that have not been implemented. This can be seen, for example, in the fact that since 2015, after the World Cup, there has not been any expansion of the BRT System MOVE. The report affirms that

[5] These percentages only take into consideration the trips conducted by motorised transport (walking and cycling excluded).

after 2015 there have not been any measures to favour public transport over private vehicles. Until 2018, only 29% of the planned exclusive bus lanes were implemented (BHTrans & ObsMob-BH, 2019).

Another interesting indicator is the budgetary execution, which until 2018 presented annual values below 30%, number that is significantly below the 95% target set for 2020. Moreover, the percentage of the municipal budget spent in mobility reached its highest point in 2013, as a result of the projects to be inaugurated during the World Cup, but in 2016 the investments in mobility represented only 3.1% (BHTrans & ObsMob-BH, 2019).

Furthermore, the report states that there is a clear political inaction with regard to the measures proposed by the PlanMob-BH to promote active mobility such as traffic calming measures, e.g. Zones 30, the expansion of the cycling infrastructure, as well as educational and awareness raising campaigns on the topic (BHTrans & ObsMob-BH, 2019).

According to the staff of BHTrans (in an interview), the technical institutions such as BHTrans continue the implementation of the goals set in the PlanMob-BH. However, there is definitely a different approach from the new mayor. His priority is to deal with the most urgent situations, leaving aside the long-term strategic planning. Thus, when it comes to access to municipal finance for the implementation of the projects defined by the PlanMob-BH, there are other priorities in the mayor agenda.

To summarise, climate change mitigation and adaptation is not among the highest priorities of the current mayor. However, there is a clear institutional framework, a qualified and experienced staff, related to climate change mitigation measures that is being pushed forward by the technical bodies independently from the mayor. The role of these institutions is that of working together with the new elected mayors in the implementation of the already approved plans / measures / policies.

18 Case Study: Moscow, Russia

Moscow is the administrative, political and economic capital of Russia, and is one of the three cities with federal status (e.g. a city and also a region), along with St. Petersburg and Sevastopol. It is home to 12.6 mln inhabitants (according to official date for January, 2019, from the Federal State Statistics Service, informal population estimations vary from 14 to 20 mln inhabitants), the centre of Moscow metropolitan area (which consists of Moscow and surrounding suburbs with a population around 17 mln people). The area of Moscow is 2561.5 square km, with a population density of 4880 inhabitants per square km (data from the federal State Statistics Service, 2019). The city is governed by a legislative and executive branches of power. Executive branch of power consists of Moscow government, and the Moscow mayor as the head of it (directly elected by city residents every five years). Legislative power is the Moscow city parliament (Duma), consisting of 45 members.

Moscow is a main economic centre for Russia. The population of the city has been growing over the last few years, with more people from other regions of Russia and surrounding former Soviet Union countries moving in to the city.

18.1 Urban environmental protection challenges

Moscow, as with all growing cities across the globe, faces challenges brought about by urbanisation. Within the realm of environmental prosperity, Moscow must combat air quality and natural ecosystem degradation, noise pollution, waste utilization problems and further negative effects of climate change.

Air pollution

Motor vehicle emissions are the biggest contributor to air pollution in the city. Open or unproperly managed landfills surrounding Moscow also contribute to air pollution in particular neighbourhoods in the city. Other sources of air pollution include wastewater treatment plants, waste incinerators and Moscow refinery. Overall, according to official statistics (Moscow Department for Environmental Management and Protection 2019), the amount of polluting substances present in the atmosphere has gone down by 21% since 2010.

Water pollution

Water quality has been getting better over the last few years, the overall volume of wastewater discharged into bodies of water has gone down by 20% over the last 10 years. Moscow wastewater treatment plants are regularly being renovated. Still, quite a few water problems remain persistent, including illegal discharges and pollution of smaller rivers (also runoffs from highways, landfills, etc).

Noise pollution

Noise pollution is a very urgent environmental challenge for Moscow. With its developed transportation network and increasing construction (and demolition) activities, 37% of the Moscow population, live on the territories with the noise level above the norms, next to the highways (B. Revich, 2017). Up till 70% of the Moscow territory are under noise pollution from various sources (Moscow Department for Environmental Management and Protection, 2017).

Climate Change and its effects

Moscow's emissions of greenhouse gases has been going down recently (to the level of 78-79% from the level of 1990), mainly due to switching to natural gas generation, cogeneration of electrical energy and heating, modernization of energy grid, introduction of stricter vehicle and

fuel standards (Evgeny Gasho, 2017). The main sources of greenhouses gas emissions in the city would be energy generation, vehicle (transport) emissions and landfill emissions.

Climate change is primarily related to concerns regarding dangerous weather events, heat or cold waves, infrastructure resilience, public health, degradation of ecosystems (City of Moscow, 2018-2019).

Urban green spaces and spatial planning

Intensive housing/infrastructure, including road infrastructure construction in the city leads to the fact that the green spaces in city keep shrinking. Over the last 15 years Moscow has lost 700 hectares of green areas (Greenpeace, 2016). City authorities develop tree planting programs, while also creating nature protected zones in the city. However, with land and real estate prices skyrocketing, lobbyists are often eager to destroy a park or take up a part of it for construction. Most of new construction is also multi-storied housing in Moscow suburbs, built quickly and often in an unsustainable way.

Waste generation and management

Moscow produces around one fifth of all Russia's household waste (approximate 11 mln tons of municipal solid waste), 90% of which goes to landfills, the rest to incinerators (there are three incinerators working in the city), and a tiny proportion going for recycling. Most of landfills accepting municipal solid waste from Moscow up till recently were located in the Moscow region (a region surrounding Moscow), with the total amount of 15. However, over the last few years, with the growing population and consumption in Moscow, most of the Moscow region landfills became overfulfilled, and in some cases also improperly managed. This has led to massive public protests in the region (of communities living next to those landfills) and temporary or permanent closure of a number of them. Additionally, the government of Moscow makes arrangements with other regions of Russia to transport municipal solid waste by rail to new landfills constructed there (which in turn has provoked further public protests in those regions). Separate waste collection and recycling have been slowly developing in Moscow (and a number of recycling facilities appearing around Moscow).

18.2 Cross-sectoral policies and measures to protect the urban environment

Over the last years the city of Moscow has been trying to implement an ambitious environmental protection policy. It comes as a reaction to a number of factors, among them: global environmental and climate agenda, increasing environmental awareness in Russia, and in Moscow in particular, among general public, an ongoing reform of environmental legislation in Russia. Over the last few years Moscow has been modernizing its air monitoring system, wastewater treatment facilities, introducing new regulation of vehicle and fuel standards, realizing a number of tree-planting programs in the city, reforming road infrastructure, developing climate adaptation plans. Over the last 10-15 years the city has also made significant progress in the area of energy and water efficiency (E. Gasho, 2017-2018).

Still, there are very few (almost none) cross-sectoral or integrated policies developed, adopted or being implemented in the city. Quite a number of environmental policy measures are distributed across various branches of the city government (e.g. departments). For example, air and water quality, green zones and climate change are within the responsibility of Department for Environmental Management and Protection, transportation is the responsibility of Department of Transportation, waste management – of Department for Housing and Communal Services. Table 22 provides an overview of the most important environmental policies of the City of Moscow.

Table 22: Environmental policies in Moscow and their relation to activities in urban environmental protection

Cross-sectoral policies	Air quality	Climate Change	water quantity	waste ma-nagement	Urban green spaces and spatial planning	Noise
Moscow Environmental Strategy till 2030 (still in draft form, probably will not be adopted in its current form)	x	x	X	x	x	x
Moscow Climate Adaptation Plan (still in draft)		x			x	
General plan of Moscow (adopted in 2010)					x	
Moscow city program on environmental protection (2011-2016)	x	x	X	x	x	x
Governmental Decree of the City of Moscow "New Ecological Policy till 2030" (2014, amended in 2016))	x	x	X	x	x	x
A set of legislation introducing a new system of waste management in Moscow (still being developed, due to come in full force in early 2022)	x	x		x		

Source: Websites of City of Moscow, own compilation, Wuppertal Institute

Sectoral Strategies, policies and by-laws

The city also stipulated a number of sectoral policies, which are named in the following (Source: Websites of the City of Moscow, interview with the experts of Department for Nature Use and Environment). Each strategy may be complemented by the implementation of by-laws.

Buildings

City Building Code of Moscow, Documents for area planning in Moscow, Rules for Land Use and Construction, Program of Renovation of Housing in Moscow (adopted in 2017, works till 2032).

Disaster Management

Moscow city legislation on protection of population and the territory of the city from natural and technological disasters. All other major disaster risk management legislation is of federal level.

Human health

Moscow city program „Development of healthcare of Moscow", for 2012-2020, Moscow City territorial program of state guarantees of free healthcare for citizens in Moscow, A program of social support for some groups of citizens in Moscow in providing them with free medication according to the recipes.

Transport

State Program of the City of Moscow "Development of the Transport System", Moscow city scheme of development of cycling infrastructure, City legislation supporting the development of carsharing in Moscow, Various city programs supporting the development of e-transportation in Moscow.

Waste Management

Territorial scheme of waste management in Moscow, City of Moscow legislation about choosing a regional operator whose task will be to manage solid municipal waste, City of Moscow decree on development of separate waste collection of solid municipal waste in Moscow, Waste collection and management tariff policy

Water Management

Most of water regulation in Moscow is represented by legislation of federal level. Water preparation, purification, delivery, as well as wastewater treatment is being managed by a city-owned company Mosvodokanal.

18.3 Overview of activities in different fields

The following sections provide a brief overview of the most important activities in different fields, taking into account the above mentioned strategies and policies.

Air pollution

The city of Moscow has been realizing a number of city programs, initiatives and action plans for tackling air pollution. According to the head of the Department for Nature Use and Environment of the City of Moscow (speaking at the Moscow Urban Forum, July, 5th, 2019) overall volume of pollutants in Moscow has decreased by 21% since 2010.

Among the main measures to tackle air pollution in Moscow: developed of over-ground and underground public transportation, renewable of buses in Moscow (all buses in Moscow are not of the EURO 4 or EURO 5 class, including the electro-buses), restrictions on private car usage (introduction of paid parking in downtown Moscow), support of development of cycling and e-vehicle infrastructure, development of pedestrian and cycling infrastructure, modernization of energy generation facilities, including cogeneration of electrical energy and heating (Moscow energy generation is almost 100% natural gas based), moving out industrial facilities out of the city, modernization of the Moscow oil refinery, tree planting programs, development of air monitoring control network (currently 56 stations) with real-time air quality information and readings and summaries for the previous day. Monthly reports and annual episode reports (where pollution levels exceed the accepted guidelines) are also available.

Climate change and its effects

Over the last few years climate change have become one of the Moscow city priorities in its further development plans. The city is striving to become a low-carbon, resources efficient and climate resilient (City of Moscow, 2017-2019). Data about GHG emissions (and reductions) is not officially included in Moscow's statistics, and is often mentioned by the city administration as one of the targets and reference points. The city has also become the first city to join the C40.

The Department for Nature Use and Environment has also been developing a city climate adaptation strategy. There are studies and research papers analysing climate risks (including health risks) for Moscow.

To mitigate climate change, the city has implemented a range of policies and by-laws in all sectors, mainly energy and transportation.

Still, climate mitigation factors are still not mentioned in city energy and transport strategic development documents (and also in none of the socio-economic strategic documents for future development of the city). There is also limited cooperation between various departments of city government, and almost none cross-sectoral projects on climate mitigation.

Water pollution

Regular ongoing reconstruction and construction of new wastewater treatment facilities have allowed for a 33% decrease in pollutants being discharged in Moscow water bodies since 2010, among them 1.3 times less of oil products and 1.7 times less ammonium ions (Report on the State of Environment in Moscow 2018). The content of some pollutions in Moscow rivers has been steadily decreasing of the last few years, however, in some rivers the levels of pollution still remains medium or high, especially with oil products. In winter and spring using of anti-snow and anti-icing chemicals also brings significant pollution for ground and surface waters in the city.

The city administration has realized a number of programs which suggested cleaning water in city lakes and ponds, opening public beaches in city parks.

Waste generation and management

The city of Moscow, among with other regions of Russia is going through a reform of waste management. The reform implies a number of policies aimed at reducing the amount of waste being deposited at landfills, developing separate waste collection, and recycling. With more than 90% of all household waste up till recently ending up in landfills, current plans include developing recycling facilities and also building further incineration plants (which continues causing public protests), as well as modernizing existing landfills (including supporting biogas production). The reform is going rather slowly, and the city of Moscow has been pushing deadline for many actions for a number of years ahead.

Other policies

With respect to noise pollution, the city has introduced stricter regulation on night-time construction. Concerned citizens can also report noise to a local police station, to the Federal Service on Surveillance for Consumer rights protection and human well-being or to the Department for Nature Use and Environment. Moscow “quiet” hours are 11 pm to 7 am, private reconstruction works are prohibited from 7 pm to 9 am and from 1 pm to 3 pm, also on Sundays and public holidays.

Still, transportation noise (mainly from highways and busy streets downtown) remain to be an important source of noise pollution.

In the area of green zone, the city continues to realize tree planting programs, also on the territories of former industrial districts, while also creating new parks and boulevards. According to statistics from the Department of Nature Use and Environment, more than 50% of the area of Moscow (not including the new areas in the so called New Moscow, when the area of the city increased by 2.4 times) are covered by green space. In former industrial areas there is a target for green space to reach 15%.

There is an ongoing monitoring and a registry of vegetation on all green spaces in Moscow. In 2018, only 21,1% of all plants (trees and shrubs) have been found to be healthy and resilient.

18.4 Spotlight: Air pollution reduction

In Russia maximum allowable concentration (MAC) are being widely used for air quality/pollution measurement and regulation, both on federal and regional levels. The latest updated version of the MACs for various pollutants has been released by the Federal Service on Surveillance for Consumer Rights Protection and Human Well-Being and the Chief Sanitary Doctor of Russia in January, 2018.

Table 23: Russian Maximum Allowable Concentration Values

Pollutant	Maximum single (mg/m3)	Daily Average (mg/m3)
Nitrogen Dioxide (NO2)	0.2	0.04
Sulphur Dioxide (SO2)	0.5	0.05
Particulate Matter (PM10)	0.3	0.06
Particulate Matter (PM25)	0.16	0.035

Source: Federal Service on Surveillance for Consumer Rights Protection and Human Well-Being 2018

Moscow's work to drive down air pollution includes a number of policy measures in the areas of energy generation, transportation, city planning and management of green zones. The measures in the area of energy generation included switching almost all of electricity and heating generation in Moscow to natural gas, developing co-generation of electricity and heating, and modernizing the energy grid. In the post-Soviet era most industrial facilities in Moscow have either closed down or moved out of town with the only exception of the Moscow Oil Refinery in the south-east of the city (the refinery is also going through a process of modernizing its production process, aiming to decrease emission of pollutants). Wastewater treatment plants, two waste incineration plants and landfills surrounding Moscow also play their role in air pollution in the city, and they are also currently going through modernization processes.

The measures in the area of transportation include: introduction of paid parking, developing of pedestrian and cycling infrastructure (making pedestrian walks wider, creating city bike-sharing programs), supporting car-sharing programs, a ban on sales of vehicle fuel of an ecological class lower than EURO 5, limitations for heavy duty vehicles with low ecological classes (EURO 0, 1,2), city program on renewal of buses with new models (engines EURO 4 and higher) and electro-buses, a target for no diesel buses from 2021, construction of new metro and above-ground rapid transit lines, introduction of financial incentives for owners of electric cars, and development of an e-vehicle infrastructure.

The City of Moscow monitors air quality and provides an online air quality reading service, which provides real-time air quality information and readings as well as summaries for the previous day. Monthly reports and annual episode reports (where pollution levels exceed the accepted guidelines) are also available. This includes an air quality monitoring network which consists of 56 stationary and three mobile air quality monitoring stations across the city. Information about air quality is presented online on the Mosecomonitoring website (Mosecom n.d.).

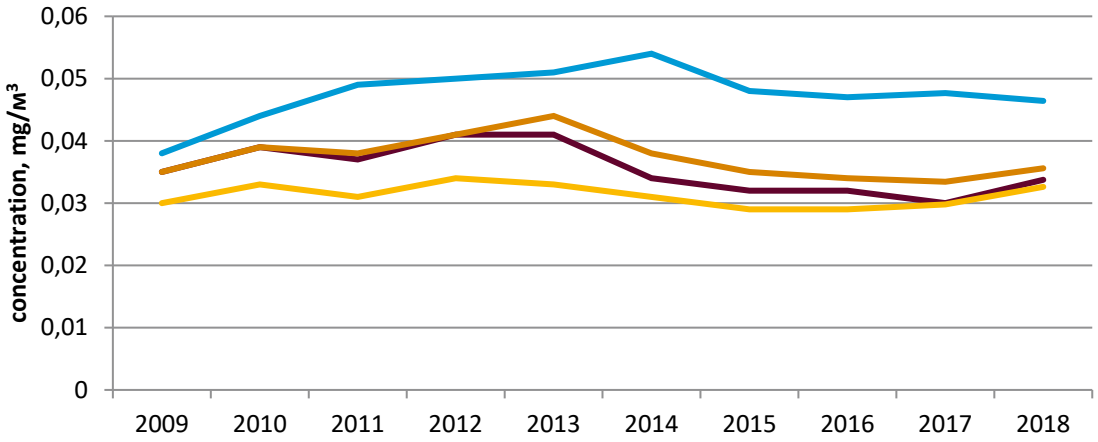
Outcomes

In the following, the measures' effectiveness is compared by tracking the evolution of the air quality starting with 2010 (City of Moscow 2018).

The „City of Moscow Report on the State of Environment 2018" (the reports have been published since 1992) provides data for air quality for the timeframe 2010 (in some cases 2008) -2018. In this report, six main air pollutants are measured and used as indicators (S02, NO2, NO, CO, PM10, O3). In the following, these six indicators will be briefly described with the help of graphs. Thereby, values will be distinguished according to the location of measuring stations located at highways (blue lines), mixed use territories (violet lines), housing areas (yellow lines) and the overall average in the city (brown lines).

On average, NO2 levels have been falling since 2013, due to the decrease in NO2 pollution in housing areas and mixed territories in the years 2012 to 2014, whereas NO2 levels have been

Figure 18: Average Concentrations of NO2 in the period 2009-2018

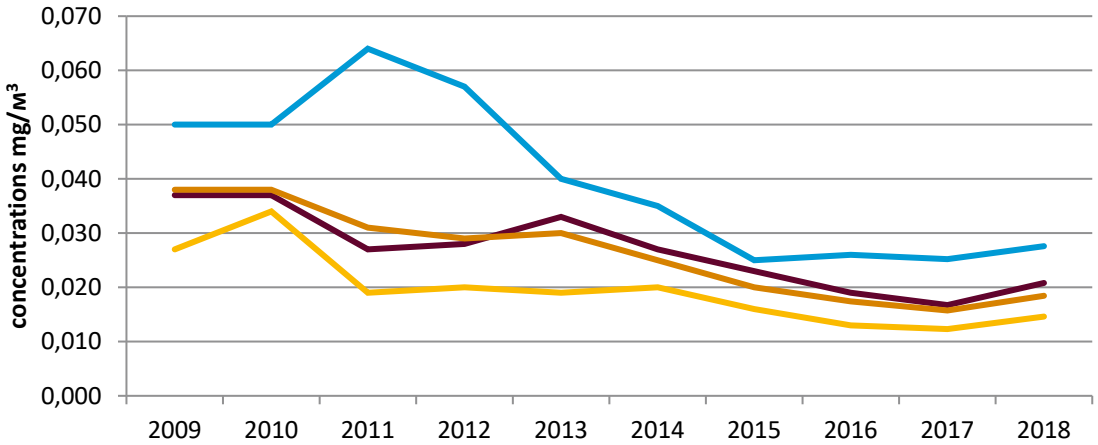


falling at highways since 2014.

Source: Report on the state of environment in Moscow 2018

NO pollution has generally decreased over the years, it is now half of the levels of pollution from 10 years ago. The average daily NO concentration is around 0.3 of the maximum allowable concentration. It is the highest around highways and other roads with heavy traffic load.

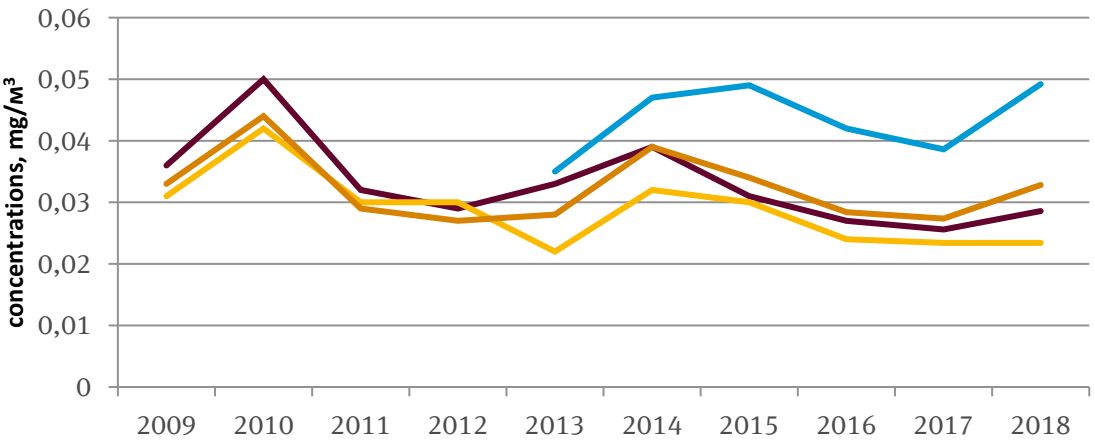
Figure 19: Average Concentrations of NO in the period 2009-2018



Source: Report on the state of environment in Moscow 2018

Figure 20 shows the average concentrations of PM10. On average, there has been a peak in PM10 levels in 2010 and 2014. Since 2017, levels are also rising again, whereby values measured at highways make up the highest proportion measured.

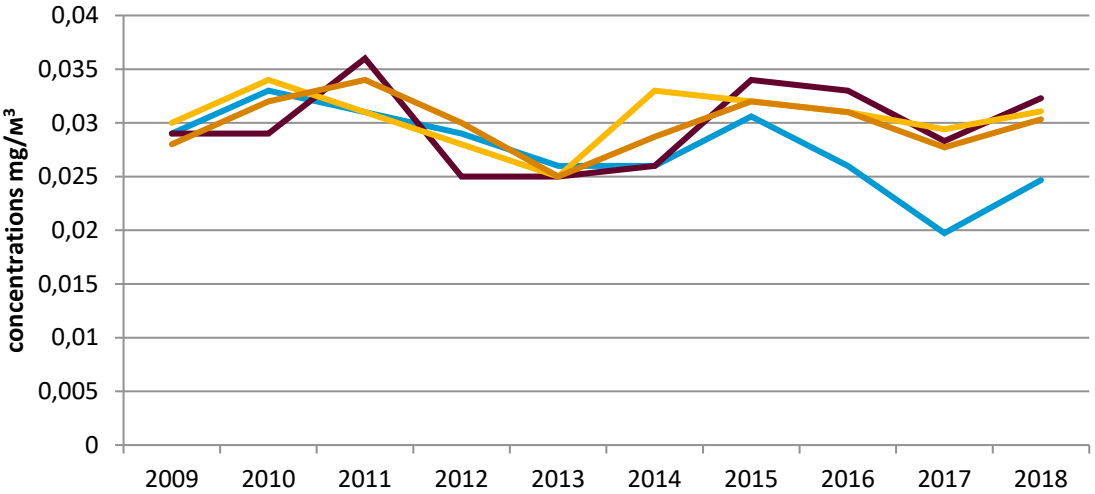
Figure 20: Average Concentrations of PM10 in the period 2009-2018



Source: Report on the state of environment in Moscow 2018

Figure 21 shows the corresponding levels measured for O3 levels. Values at all available types of measuring stations have been approximately similar up until the year 2015. Since then, O3 values measured at highways fall clearly below average.

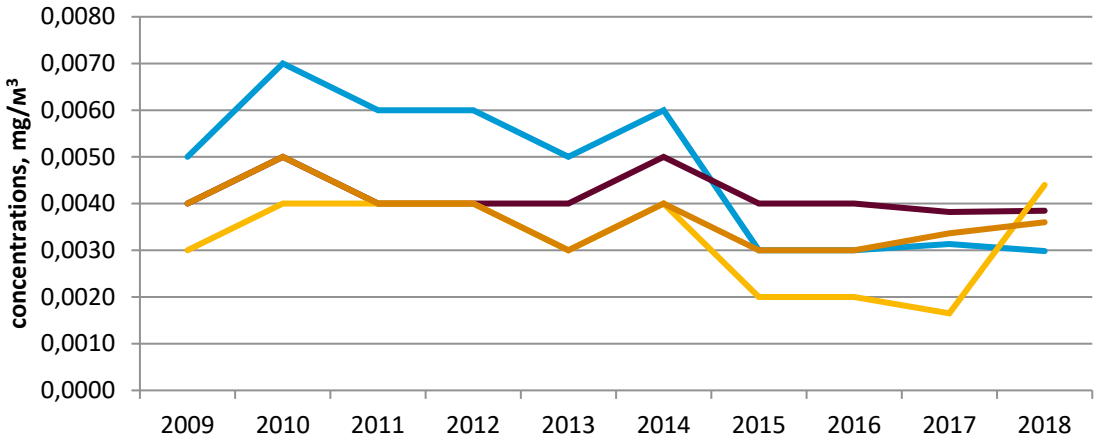
Figure 21: Average Concentrations of O3 in the period 2009-2018



Source: Report on the state of environment in Moscow 2018.

Finally, average concentrations of SO2 have been constantly falling, in particular during the period 2014-2015. Since 2017, however, SO2 levels in housing areas are rising.

Figure 22: Average concentrations of SO2 in the period 2009-2018



Source: Report on the state of environment in Moscow 2018

Conclusion

In summary, over the past 10 years, air quality in Moscow has significantly improved with respect to certain pollutants (NO, CO), whereas improvements with respect to others (O3, PM10, NO2) are limited. The lowest level of air quality is still around highways and heavily used streets, with cars, heavy duty trucks and energy generation facilities remaining to be the main source of pollution. Realized measures of environmental policy have certainly brought some benefits (average annual concentration of CO and NO have fallen by 2.1 times over the last 8 years), but concentration of other pollutants (NO2, PM10) are decreasing at a slower pace than expected – by 10% from the levels of 2010 for NO2 and by 1.5 times from the level of 2010 for PM10. The concentrations of O3 remain to be at the same level. The concentration of SO2 is 10 times lower from the maximum allowable concentration values and annual averages remain almost constant. Overall, it seems like policy measures tackling air pollution in Moscow did have some effect, however, further regulation of the sector is needed.

18.5 Spotlight: Sustainable Mobility

Moscow has achieved considerable progress with regards to sustainable mobility, covering a wide field of activities that encourage its sustainable urban transition pathway. The following will provide an overview over three substantial elements of sustainable urban mobility, including the development and promotion of public transport services, the establishment of electrified and shared mobility transport structures, as well as the expansion of active mobility infrastructure, including aspects of road safety in the city.

Public transport

Moscow has developed its public transport system into a central element of its urban infrastructure. Besides its metro network, and new overground rapid transit lines surface transit consists of a grid of buses, trolley buses and trams. In 2016, the entire public transport system carried around 3.58 billion individuals (Kodukula et al. 2018). Overall, Moscow emphasizes the integration of transport means into the city at various levels.

In 2013, for instance, the Troika Card was introduced, a reusable plastic card which gives not only Muskovites but also the broad public access to all public transport services (Domingo 2016). A single ticket of Moscow's public transport system covers a share of approximately 13% of average food expenditures per day, which is, in comparison to other European cities (e.g. in

Berlin public transport equals 39% of average daily food expenditures, whereas in London it equals 80%), relatively affordable (Kodukula et al. 2016).[6] Moreover, in 2016, it opened up the Moscow Central Circle, a 54 kilometres long metropolitan railway line to increase and improve urban sustainable mobility. This metro line is integrated into the urban public transport system with regards to interconnections to other transit services, including metro, commuter trains and surface transport, a joined passenger ticketing system as well as integrated working hours for employees of public transport services. This project entailed not only the restoration of obsolete transport stops as well as the creation of new transport stations and relevant transit nodes, but also encourages the revival of deserted industrial zones. As such, the Moscow Central Circle can be considered not just a transport project, but also an urban sustainable development project (UITP 2016). In 2019, the first two lines of the Moscow Central Diameters, the new surface metro lines, have been opened, connecting the city with more remote towns of the Moscow region (Government of Moscow 2019). The first two diameters, which have been launched, have 57 stations altogether, 19 of which are connected to metro lines, the Moscow Central Circle (MCC) and radial railway lines. According to the Moscow government, the first stage of the program alone shall facilitate transportation for 3.7 million people, and shall contribute to a reduction of private vehicle usage and traffic congestion.

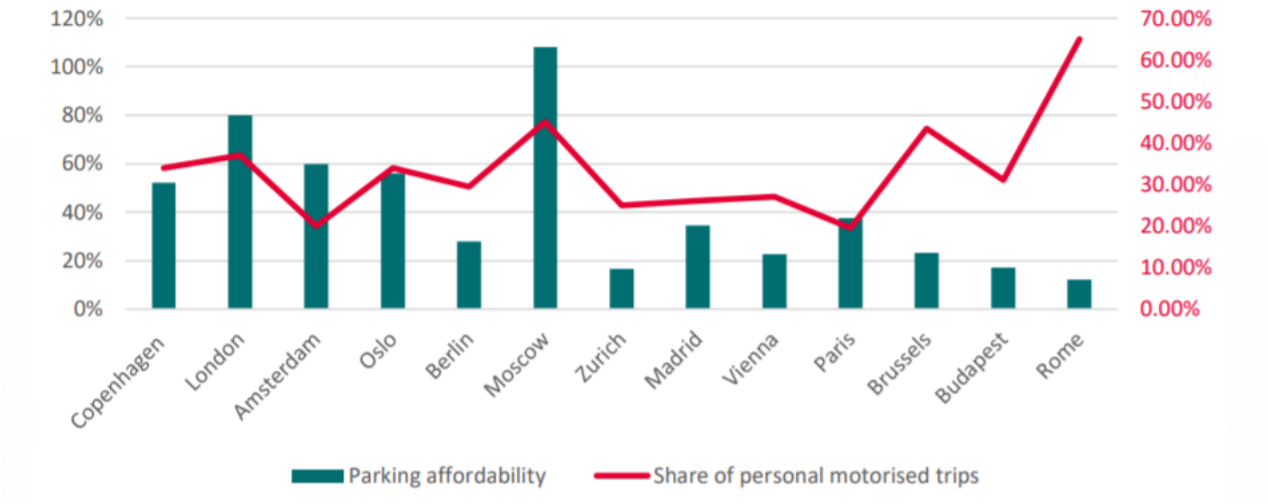
Electrified and shared mobility

Although public transport has a relatively high modal share in Moscow, private motorized transport is almost as high, adding up to a share of 45% of transport modes and leading to high congestion levels in the city. Therefore, Moscow municipality has developed various strategies to lower congestion levels as well as the usage of private cars.

One relevant factor is the introduction of high parking costs, adding up to around 5.30€ per hour (the minimum cost is 1,17€ per hour (Government of Moscow n.d.), which is, compared to other European cities, relatively high (e.g. hourly parking in Berlin with a share of 30% of private vehicles, adds up to 2.00€, which is equal to a share of 28% of daily food expenditures (Kodukula et al. 2018). Figure 23 illustrates the relative affordability of parking in urban areas as a share of daily food expenditure. As the figure shows, parking in Moscow is expensive and intended to reduce the high proportion of private motorized transport modes. In addition, when comparing the relative expenditures on public transport (13% of daily food expenditures) and parking (80-108% of daily food expenditures), it is evident that Moscow municipality is not only aware of the congestion situation on its streets, but has also implemented various policies, programs and projects that encourage and promote the usage of urban sustainable mobility options.

[66] In economic studies, daily food expenditure (2,400 calories per day) is commonly considered as a purchasing power indicator. Kodukula et al. (2018) use it for comparison purposes of a cross-country study.

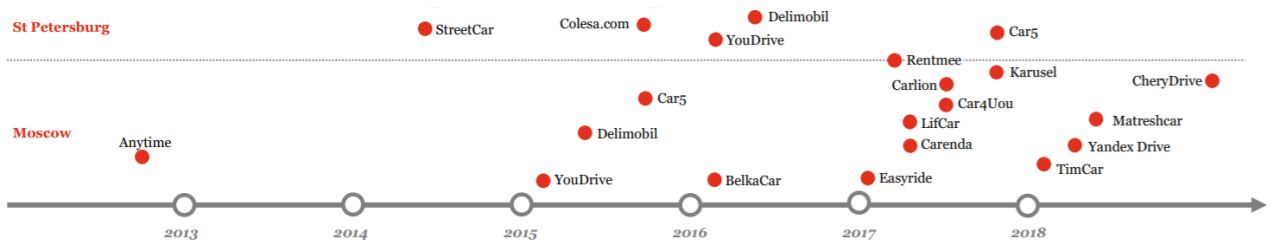
Figure 23: Relation between parking prices vs share of motorised modes



Source: Kodukula et al. 2018

These programs include amongst others various carsharing projects. A PWC consumer survey (2018a) shows that among the main concerns over privately owned vehicles are traffic jams and long commuting times (66% of responses) as well as parking problems and high parking costs (65% of all responses). As reaction to this, the first car-sharing operator started business in 2012 in Moscow. Since 2015, the concept of car-sharing has been supported and promoted by the city administration and could, therefore, develop and expand dynamically (PWC 2018). Figure 24 illustrates this development. Moscow's car sharing market is rapidly growing and includes around 12 now operators (although four operators, including Delimobil, Belka Car, Youdrive and Yandex Drive are predominant by covering 94% of the car sharing market share. Easyride closed down in 2018, TimCar and Carlion closed down in 2019. Carenda closed their operations in Moscow and moved to St. Petersburg).

Figure 24: Timeline of car sharing operators entry to Russian cities



Source: PWC 2018

Furthermore, Moscow emphasizes the electrification of its shared car fleet, which added up to around 281 vehicles in January 2017 (Kodukula et al. 2018). Besides that, since 2018, Moscow's diesel city buses as well as trolley buses have been replaced with a new electro-bus fleet, consisting of 220 vehicles, which by October 2019, have transported approximately 16 million passengers. Although the electro-buses are considered as environmentally-friendly, mitigating noise pollution and more energy efficient, they are criticized because of yet a high usage of diesel for heating and the associated costs during cold seasons (Government of Moscow 2019b).

Active mobility and road safety

Compared to the high modal shares of public and private motorized transport, Moscow's mobility flows are characterized by low levels of active mobility, including a 3% share of walking as well as a biking share of the same amount (Kodukula et al. 2018). This might be due to various aspects.

Moscow lacks a holistic approach regarding the integration of active mobility modes into the transportation system of the city. This is reflected in its high share of bicycle crashes and pedestrian fatalities compared to other European cities (Kodukula et al. 2018). Figure 25 illustrates this. While Moscow's active mobility share is approximately similar to Rome, there is, however, a considerable difference in road safety conditions.

Figure 25: Correlation between active mobility and fatalities 2016

Source: Kodukula et al. 2018

Nevertheless, an integrated active mobility infrastructure is in progress. For instance, it implemented various programs with regards to the expansion of urban green zones by creating parks, boulevards and initiating tree planting programs (Moscow Department for Nature Use and Environment 2019). In 2014, it introduced the Moscow Bicycle Infrastructure Development Strategy, which entailed the construction of new separate and shared bicycle lines and the installation of road signs for cyclists, complementary facilities such as bike storage, as well as bicycle traffic lights (UNECE n.d., MIC n.d.).

Another relevant program is the Pedestrian and Bicycle Masterplan 2020 (PBMP). The latter has been promoted by the Moscow Department of Transport in cooperation with the Moscow Traffic Control Centre and MosgortransNiiproyect. It aims to integrate walking and cycling into the transport structure of the city, by emphasizing the need for a more balanced urban modal share, a reduction of private motorized transport and an increase in sustainable alternative mobility options. In the context of the PBMP, the sub-program My Street 2015-2018 has been initiated

and entails the development of the Green Ring, a 80km long bicycle highway, that connects parks and green areas in the city (MIC 2014).

Additionally, progress has been done regarding active mobility by introducing a bike sharing scheme in the city in 2013. The city bike-rental scheme has now 530 stations and 5120 shared bikes. 4.25 million trips have been made in 2018 (Government of Moscow 2019a).

Hence, although Moscow's active mobility modes are negatively affected by a hostile transport environment, the municipality has achieved substantial progress in improving the conditions for active sustainable alternative means of transport as well as their integration into the transport infrastructure of the city.

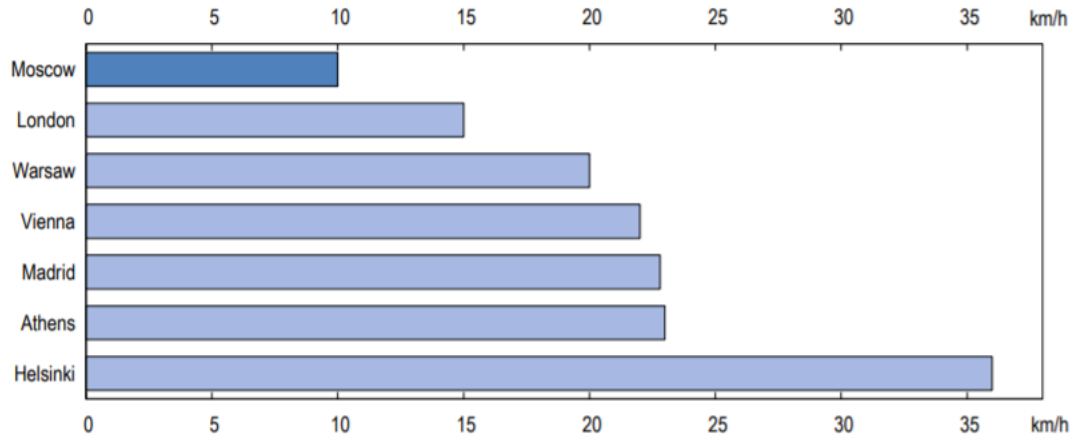
Outcomes

Although in all of the listed fields of activity concerning urban sustainable mobility, there is space for improvement, the outcomes of the abovementioned programs and projects show an overall positive effect on Moscow's current situation regarding sustainable urban mobility.

- *Public transport*: Passenger transportation via public transport modes is highly encouraged by the municipality by charging their usage with affordable prices. As a result, the 49% public transport modal share lies above average when being compared to other European cities (Kodukula et al. 2018). Although the Moscow Central Circle represents a cornerstone in the city's rail based system, the density of public transport stations in Moscow is about 4.67 stops per square kilometre, which is, compared to other cities (e.g. London has a station density of 12.4 stops per square kilometre), relatively low (Kodukula et al. 2018). This indicates, that although there are already ambitious projects implemented, such as the Moscow Central Circle, there is still space for improvement concerning coverage of public transport services.

- *Electrified and shared mobility*: To decrease the 45% share of personal motorized transport, various policies such as the increase in parking costs have been implemented. Nevertheless, in 2018, Moscow has been ranked on place 5 of the worldwide congestion index, with a congestion level of 56% (Tomtom Traffic Index 2018). This high level of traffic congestion translates into long commuting times and consequently into decreasing levels of air quality. Figure 26 illustrates average traffic speed during peak hours in various cities, including Moscow, London, Warsaw, Vienna, Madrid, Athens and Helsinki. Evidently, Moscow's average speed during peak hours is considerably affected by the traffic situation on its roads and there is a need for further policies that tackle urban congestion levels. So far, no congestion charge has been implemented nor did the municipality initiate low emission zones (Kodukula et al. 2018).

Figure 26: Average traffic speed in peak hours in selected cities



Source: Kolik et al. 2015

- In addition to parking fees, Moscow has, therefore, also encouraged and promoted the development of a large carsharing system, in particular since 2015. Specific numbers regarding the total number of Moscow's carsharing fleet are, however, not available. News and media articles record a number of 10,000 to 15,000 shared cars in Moscow as well as a considerable increase in car-sharing registrations since then (Movmi 2018). According to a PWC report of 2018, there was a total shared car fleet of around 10,500 vehicles in August 2018. For the year 2025, a total car fleet of around 25,000 shared vehicles is projected (PWC 2018).
- *Active mobility*: The programs supporting alternative transport means have achieved progress with regard to the integration of active mobility into the transport infrastructure of Moscow. Shared bicycle systems have been opened up, whose rental rates have been doubled between 2014 and 2016; more than 2700 bicycle racks were installed and extended in the urban area between 2013 and 2016, in particular at public spots such as in commercial zones, public services, transportation hubs and public institutions such as schools and museums; furthermore, bicycle carriage in public transport is free of charge since 2014 (UNECE n.d.).

Conclusion

Three main fields characterize Moscow's efforts in encouraging a sustainable urban mobility scheme: Public transport services, high parking fees, electrification and car-sharing to decrease private motorized transport, and active mobility. Empirics show that particularly public transport services are promoted by the city's municipality, which translates into a high modal share of public transport. Yet, although progress has been done with respect to decreasing congestion levels on Moscow's streets due to high usage levels of private vehicles, there is space for improvements, e.g. in form of congestion charges or low emission zones. Finally, Moscow has introduced multiple programs to integrate active mobility modes into its transport infrastructure. While further improvements in particularly regarding road safety are necessary, policies concerning Moscow's cycling culture and bike sharing structures have been successfully implemented.

19 Case Study: Kochi India

Kochi, also known as Cochin, is a major port city on the west coast of India by the Arabian Sea. It is a part of Ernakulam district in the state of Kerala. The city of Kochi is the most densely populated city in the state with the population of 0.6 million within an area of 95 km2 and 2.1 million population including the metropolitan region within an area of 632 km2, with annual population growth rate of 7% (ICLEI-South Asia, 2015). The governing civic body of the city is the Kochi Municipal Corporation, and the Greater Cochin Development Authority (GCDA) is the planning and development authority of the metropolitan area of Kochi. The city of Kochi has been a prime location for commerce, finance and industry in Kerala, and has the highest GDP in the state.

19.1 Urban environmental protection challenges

The greater Kochi is categorised amongst the critically polluted area in the country, with 24th position in compressive environmental pollution index (CEPI) carried out by the Central Pollution Control Board (CPCB) of India. The main source of pollution in Kochi are from industries, municipal solid waste and domestic waste as well as biomedical and e-waste (CPCB, 2010). Some of the major environmental protection challenges are briefly described below:

Air pollution

The key sources of air pollution in the city of Kochi are transport (including road dust), industries or construction works (including brick kilns), domestic cooking and heating, waste burning and natural salt. In Kochi, average $PM_{2.5}$ concentration was 29.1 ± 7.6 µg/m^3, which is lower than the national standard (40) though it is twice the WHO guideline (10). In Kochi, transport shares 20.2% - the highest percentage of PM2.5 concentration in 2015, other source-wise percentage share includes residential 9.6%, industrial 4.1%, dust 16.4%, waste burning 3.8%, Diesel Genset 4.6%, Brick Kiln 3.8%, sea salt 16.5% and the contribution from outside the urban airshed is 21.0%. The annual averages from the national ambient monitoring program for 5 years (2011-2015) showed that Kochi's PM_{10} was 221.6 ± 167.0 µg/m^3, NO2 38.4 ± 30.5 µg/m^3 and SO_2 10.7 ± 10.6 µg/m^3 (Urbanemissions, 2015). Even though Kochi is lower down on pollution rating compared with other metropolitan cities, vehicular pollution is still on the top. Waste burning and construction pollution had increased in recent times (Rajagopal, 2019).

Climate Change and its effects

Transport is one of them major contributor for GHG emissions in many Indian cities. In the comprehensive ranking of six megacities and eight metropolitan cities in India, Kochi ranks fifth in the lowest overall emissions and energy consumption related to transport. However, Kochi is the third highest city when it comes to per travel trip and energy consumption (Giri, 2018). As Kochi is a coastal city, communities in the region near the coastline experience climate related shocks and stress, including the depletion of fish resources, occurrence of extreme events and loss in fishing days. The shoreline changes and sea water intrusion were the visible impacts of climate change and relocations are needed during monsoon (Nambudiri, 2017). Kochi face challenges from changing climatic conditions - a one-metre rise in sea level may submerge almost 80 per cent of the city (Government of Kerala, 2014).

Noise pollution

Sound levels of some major spot of Kochi are up to 75 decibel, which is above the maximum permissible limit of 50 decibel (TNN, 2019). Vehicular honks are one of the major causes of noise

pollution in Kochi. Noise pollution has affected even in silent zones, including the courts, premises near hospitals and educational institutions (The new Indian Express, 2019).

Water pollution and access to water

Kochi lies in a heavy rainfall region, but now the city faces a shortage of reliable water supply, because water in the city is polluted far above the safety limits (Government of Kerala, 2014). Water demand in Kochi is increasing due to growth in population and growth in service sector, and other economic, tourism and commercial activities (ICLEI-South Asia, 2015). The industrial water demand in the city stands at 280 million litre a day (mld), the demand from household sector is 168 mld. The ground water is over-exploited to fulfil the need in the city, but it has also been revealed as contaminated (Suchitra, 2015). The water quality in the water bodies are deteriorated due to discharge of untreated sewage into them (ICLEI-South Asia, 2015).

Therefore, the city faces many challenges in the water sector, ranging from inadequate water distribution network, depleting groundwater quantity and quality to increasing water pollution, population growth and changing land use patterns that result in loss or depletion of water resources. The drought map of Kerala shows most parts of Kochi are in moderate drought conditions. The water conservation measures to tackle this is still low, only 24 percent households implement it (Suchitra, 2015). On the state level, the Kerala water Authority (KWA) is implementing projects in the water sector under JnNURM to improve storage and treatment capacity, laying distribution network in new areas in the city (ICLEI-South Asia, 2015).

Land sealing and biodiversity

Expansion of urban boundaries, population growth, uncontrolled urban migration and development activities have affected the urban biodiversity in the coastal city of Kochi in India. Industry and construction activities are increasingly destroying the wetlands and paddy fields surrounding the city. Lack of efficient pollution control measures have deteriorated the nearby river and the numerous inland canals, endangering the water living organisms. Open land area and greenery has also been fast shrinking, alienating the birds and plant-dependent species such as insects and also creating heat island effect within the city (Challenges to the biodiversity in a fast-growing tropical city, 2008). The study between 2001 and 2013 has shown the urban sprawl, assessing the built-up area of around 17% in 2002 to 23% in 2013. Due to the rise in the number of construction projects, Kochi's dry land (less vegetated areas) had been continuously decreasing (Perinchery, 2018). From the study between 2007 and 2013, it is observed that the increasing number of buildings has created urban heat island in the city of Kochi of 4.6 degree Celsius in winter (Analysis of urban heat island in Kochi, India, using a modified local climate zone classification, 2014).

Waste generation and management

Municipal solid waste is increasing in the city of Kochi with rapid urbanisation and growing economic activities. The residential areas of Kochi show that the waste footprint has been increasing from 0.129 hectares per capita in 2010 to 0.0163 hectares per capita in 2013, accounting 26.35% increase within 4 years. Of the total waste, paper waste constitutes 2.6%, glass 5.1%, metal 10.5%, organic 80.1% and plastic 1.9% (Waste Footprint of Kochi City, Kerala - An Analysis, 2016). Even though Kochi has seen significant improvement in door-to-door collection efforts through local agencies, the challenges with respect to littering and in waste recovery/ safe disposal are still a problem. Waste dumping and sullage flows in the canal and drains are adding on to the ineffectiveness of the drains in the city (Edathoot, 2018).

19.2 Cross-sectoral policies and measures to protect the urban environment

The city of Kochi has been taking actions to protect the urban environment by developing and implementing policies and measures. As an initiative of the State planning Board, Kochi has Kerala Perspective Plan 2030, released in 2015, with a long-term development strategy. It has a perspective plan to make the state a prosperous, knowledge-driven, competitive and eco-efficient economy (The new Indian Express, 2015). On the environmental sustainability aspect, it includes the fact that the overall population growth in the State is low and is concentrated in a few urban agglomerations. These urban centres require sustainable power, water, sanitation and transportation systems of international standards, as well as the need of proper green spaces and preserved coastal zones. The vision for environmental sustainability include: upgrade ecosystems, biodiversity and resources through sustainable production systems and consumption; protect wetlands; conserve the World Heritage biodiversity of the Western Ghats; increase energy efficiency to save 10 per cent of Kerala's energy and water consumption by 2030; recycle between 60 and 75 per cent of waste generated depending on the type of waste; and identify and maximize the use of sustainable resources (Government of Kerala, 2014).

The Union Ministry of Environment and Forest ranked the greater Kochi area as the 24th polluted industrial cluster in the country in its Comprehensive Environmental Pollution Index. Kerala state pollution Board (KSPCB) is also carrying out cross- sectoral actions to tackle environmental challenges in Kochi. The action plan with short and long-term measures has been formulated by the KSPCB for controlling pollution in the Greater Kochi Area. The short-term measures proposed include "industrial pollution control, monitoring arrangement and demarcation of areas", and the long-term measures include "common effluent treatment plant, common pipeline for treated effluent, electricity supply improvement and continuous monitoring of water and ambient air quality" (The Hindu, 2010). The KSPCB issues consent to industries with conditions to regulate the quality and quantity of emission and set down the frequency for monitoring the emission (KSPCB, 2014).

Table 24 provides an overview of various cross-sectoral policies and measures in Kochi and their relation to activities in urban environmental protection. In some of the policies in the city, the difference in enforcement and compliance is an issue.

Table 24: Cross-sectoral policies in Kochi and their relation to activities in urban environmental protection

	Air pollution	Climate Change	Noise control	water pollution and accessibility	Land sealing and Biodiversity	Waste management
Smart Cities Mission: Kochi ranked 5th among the 20 cities	x	x		X	x	x
Atal Mission for Rejuvenation and Urban Transformation (AMRUT) mission: Kochi is one of the AMRUT city in Kerala		x		X	x	x
Swachh Bharat (Clean India) mission: Kochi Environmental Swatch	x	x			x	x

	Air pollution	Climate Change	Noise control	water pollution and accessibility	Land sealing and Biodiversity	Waste management
Bharat ranking is 75.08						
Solar cities master plan	x	x				
National Urban Transport Policy (2014)	x	x				
Inland Water Transport Policy	x	x		X		
Municipal Solid Waste (Management and Handling) Rules 2000 and revised SWM, Rules 2015	x	x				x
Municipal Solid Waste Management Manual (2016)	x	x				x
State Government's 'Waste-free Kerala' initiative.		x				x
'Raahgir' (Car-free Day) events	x	x	x			
Draft policy on electric vehicles (EV): By Kerala state government	x	x				
India's National Solar Mission. –solar powered airport in Kochi	x	x				
Kochi Solid Waste Management bylaw (proposal state)		x				x
Kochi City Development Plan (CDP)	x	x		X	x	x
Ban on plastic carry bags below 50 microns		x			x	x
Kochi Solar City Cell	x	x				
Noise Pollution (Regulation and Control) Rules, 2000		x	x			

Source: own compilation, Wuppertal Institute

19.3 Overview of activities in different fields

The following sections provide a brief overview of the most important policy and measures in different fields.

Air pollution

Kochi follows Air (Prevention & Control of Pollution) Act, 1981 (amended in 1987), formulated by Kerala state pollution Board (KSPCB). Under the Air Act, KSPCB plans a comprehensive programme for prevention, control and abatement of air pollution and to secure the execution thereof. It advises the State Government on prevention, control or abatement of air pollution; collect and disseminate information relating to air pollution; collaborate with the Central Board in organizing capacity buildings activities; and inspects control equipment and takes steps for prevention, control or abatement of air pollution (KSPCB, 2014a). With the measures implemented, the air pollution level has been reduced by about 50% from 1984 levels (KSPCB, 2014). KSPCB also assess the ambient air quality in the state under National Ambient Air Quality Monitoring Programme (NAMP). Under the programme sixteen monitoring stations have been established at different locations of the state, including industrial, commercial and residential zones of Ernakulam (Kochi) (KSPCB, 2014b).

The Central Pollution Control Board (CPCB) has carried out an environmental assessment of industrial clusters across India, including Kochi. The Urbanemissions (2015) also carried out monitoring and emission inventory activities that shows impact of air pollution in the city. The city of Kochi has initiated various actions, such as consultative stakeholder meeting, to reduce the air pollution. See “Spotlight: Air pollution reduction” in Kochi for detail.

Climate Change and its effect

Kerala State Pollution Board (KSPCB) take in charge of state as well as municipal (Kochi) to prevent and control pollution of the environment. It follows the Water (Prevention & Control of Pollution) Act, 1974 (amended in 1988), the Water (Prevention and Control of Pollution) Cess Act, 1977 (amended in 1991), the Air (Prevention and Control of Pollution) Act, 1981 (amended in 1987), and the Environment (Protection) Act, 1986 (KSPCB, 2014a).

Kochi is also one of the Smart city under Smart City mission. The smart city proposal elaborates various smart solutions to reduce emission in the city through energy management (smart meters and management, renewable sources of energy, energy efficient and green buildings), urban mobility (smart parking, intelligent traffic management and integrated multi-modal transport), as well as solutions for waste and water management (KMC, 2019). Kochi Municipal Corporation is also planning to develop a roadmap and action plan for all buildings to achieve zero carbon potential for Kochi city (WRI India, 2018). In order to reduce transport emission and enhance public transport, Kochi is starting preparatory works for Kochi metro Phase II through Kochi Metro Rail Limited (KMRL) (TNN, 2019a).

Noise pollution

The city has Noise Pollution Rules, 2000 to regulate and control noise level. Kochi Corporation, City Police and various NGOs observed ‘no honking day’ in Kochi on December 2016, and there has been an increasing demand for studies on noise pollution and its health hazards (Deccan Chronicle, 2016). The event like ‘Raahgiri’, car-free day event, demonstrates the positive impact of reduced vehicular noise.

Water pollution and availability/water management

Water pollution in Kerala state (and Kochi) is controlled through administering conditions imposed in consent issued under the Water (Prevention & Control of Pollution) Act, 1974. These conditions regulate the quality and quantity of effluent, the location of discharge and the frequency of monitoring of effluents. Large and medium scale industries as well as small scale units have put up effluent treatment plants to control water pollution (KSPCB, 2014). Kochi also has City Sanitation Plans prepared that provide strategic planning processes for citywide

sanitation sector development and include the vision, mission, and goals of sanitation development as well as strategies to meet these goals (Edathoot, 2018).

Kochi smart city proposal elaborates various smart solutions for water management (such as smart meters and management, leakage identification, preventive maintenance, and water quality monitoring), which will provide adequate water supply in the city (KMC, 2019).

Land sealing and biodiversity

Kochi's City Development Plan and environmental sustainability in the SmartCity master plan intent to maintain the nature and respect the biodiversity (KSUDP, 2017) (SmartCity Kochi, 2018). The state of Kerala has formed the Biodiversity Management Committees (BMC) in local self-government institutions, including Kochi Municipal Corporation. The committees were constituted in accordance with the national Biological Diversity Act 2002, the Biological Diversity Rules 2004 and the Kerala State Biological Diversity Rules. The committee's mandate includes conservation, sustainable use, and documentation of biodiversity and equitable sharing of benefits arising from utilisation of bioresources. BMC has to prepare mandatory People's Biodiversity Register (PBR), a document on local biological resources and traditional knowledge (Suchitra, 2015a).

Waste generation and management

With the launch of the National Urban Sanitation Policy (NUSP), the Government of India exhorted all Urban Local Bodies to prepare their City Sanitation Plan (CSP), providing them with a Framework to assist them in the process. The CSP is a comprehensive, holistic and city-wide plan that addresses universal access, safe collection, treatment and disposal of 100% liquid and solid waste. The CSP of Kochi has been prepared for the area under the Corporation of Kochi (KOC), not incorporating metropolitan region. Based on CSP, city sanitation exercise was carried out for Kochi and the city scored 41 out of 100 (ranked 81st out of 423 cities), which suggests that the city need considerable improvement (Edathoot, 2018).

Kochi follows the rules under Kerala State Pollution Control Board (KSPCB). Kochi's some of the main waste management rules are as follows:

- Plastic Waste Management Rules 2016 (for plastic waste reduction and management),
- Batteries (Management and Handling) Rules 2001 (for safe disposal of batteries),
- Biomedical Waste (Management and Handling) Rules 1998 (for proper collection, segregation, processing and disposal of bio-medical wastes in an environmentally friendly manner)
- E-Waste Management rules 2016 (for proper discard of hazardous electric components) and
- Municipal Solid Wastes (Management and Handling) Rules 2000.

Under Municipal Solid Wastes (Management and Handling) Rules, every municipality is responsible to provide facilities for collection, storage, segregation, transportation, processing and disposal of solid wastes. KSPCB need to provide authorization for operating these facilities (KSPCB, 2014a). The SWM rules 2016 emphasize segregation and waste treatment at the source, and give priority to decentralized waste management. In a decentralized system, households are responsible in waste segregation and treatment (Landfill sites, solid waste management and people's resistance: a study of two municipal corporations in Kerala, 2017). Kochi smart city proposal elaborates various smart solutions for waste management (such as

waste to energy, waste to compost, waste water to be treated, and recycling and reduction of C&D waste) (KMC, 2019). See "Spotlight: Solid Waste Management" in Kochi for detail.

19.4 Spotlight: Air pollution reduction

Air pollution reduction is India's one of the main targets to improve air quality in many Indian cities, including Kochi. In the national initiative of Smart cities mission, Kochi is one of the smart cities and ranked 5th among the 20 cities with the mission to reduce air pollution and other environmental effect. Kochi is also a part of another national initiative 'Swachh Bharat (Clean India) mission', which controls garbage combustion or open waste burning.

In order to improve air quality in urban areas, Kochi Municipal Corporation and Kochi Metro Rail Limited organized a stakeholder engagement and consultation, together with Clean Air Asia, to discuss various strategies to tackle the increasing air pollution. The multi stakeholder consultation provided a platform to bring in experts who can support the development of a Clean Air Action Plan and establish a long-term cooperation platform for stakeholders to implement effective programmes and policies on the ground in Kochi (Deccan Chronicle, 2017). A consultive multi-stakeholder meeting on Air Quality Solutions in Kochi brought together officials from the Government, major research institutes and other stakeholders including medical practitioners to discuss an inclusive strategy for Air Quality Solution for Kochi. Some of the air quality solutions are being showcased by experts from Faurecia Clean Mobility, an international organisation working in automotive industry. The consultation supports the administration of Kochi to come up with a better air quality plan on the basis on the Guidance Framework which is a voluntary framework to implement the long-term for urban air quality in Asia (KMC, 2017).

Monitoring industrial emission

The industrial clusters in Greater Kochi are categorized as the group of cities with high pollution levels, according to a study done by the Central Pollution Control Board (CPCB) in association with Indian Institute of Technology, New Delhi. Under the study, a comprehensive environmental pollution index (CEPI) was calculated that help to prioritize planning needs to improve the quality of the environment in industrial clusters. Kochi is ranked 24th position in the list, with an index of 75.08. CEPI calculation is for air, water, and land considering four factors — pollutants, pathway, receptor and additional high risk element. The pollution index is considered as critical when the total score of CEPI is more than 6. In the case of Kochi, the condition of air falls under 'severe' category. The Ministry of Environment and Forests had imposed restrictions on sanctioning new industries in clusters with CEPI score above 60 (The Hindu, 2012).

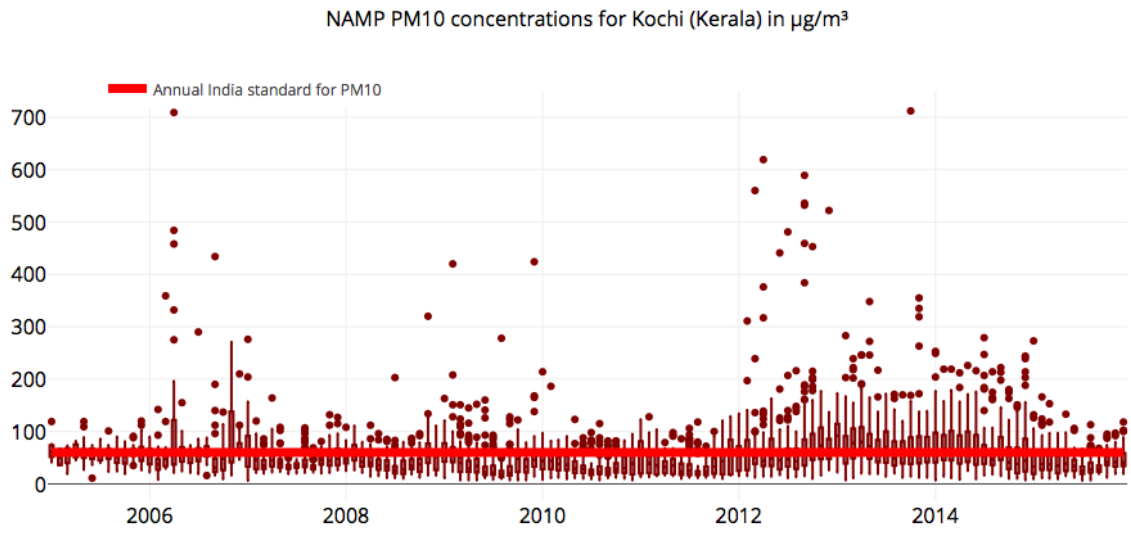
Monitoring without industrial emission

Under the National Ambient Monitoring Program (NAMP), operated and maintained by the Central Pollution Control Board (CPCB, New Delhi, India), Kochi's air quality has been monitored.

Using manual stations data

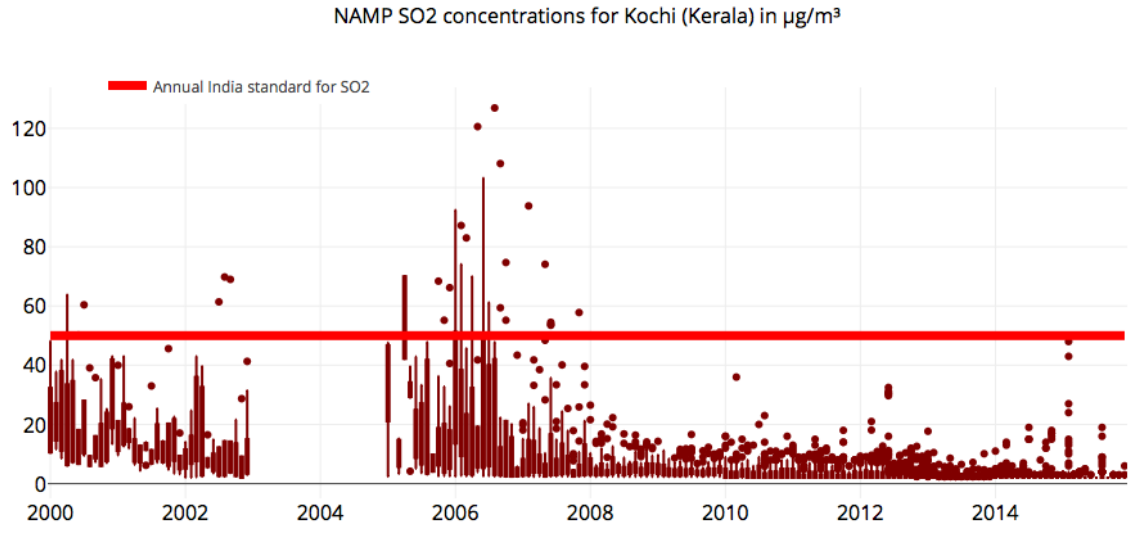
From the 7 manual stations within the city, monitoring data on PM_{10}, SO_2, and NO_2 were collected from the year 2000-2014 (see Figures 27, 28 and 29) (Urbanemissions, 2015).

Figure 27: NAMP PM10 concentrations for Kochi in µg/m³



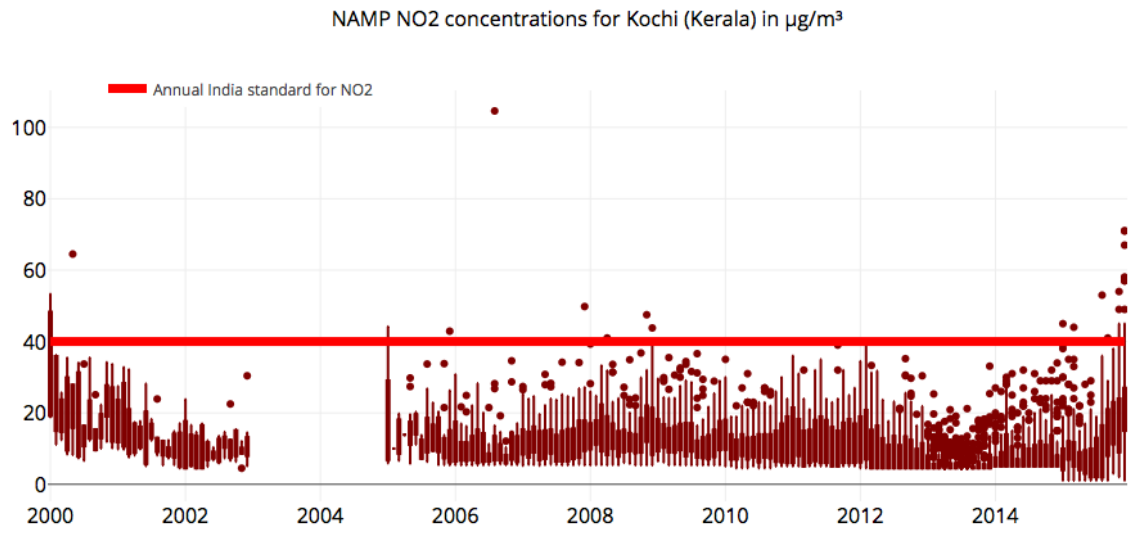
Source: Urbanemissions 2015

Figure 28: NAMP SO_2 concentrations for Kochi in µg/m³



Source: Urbanemissions 2015

Figure 29: NAMP NO2 concentration for Kochi in µg/m³

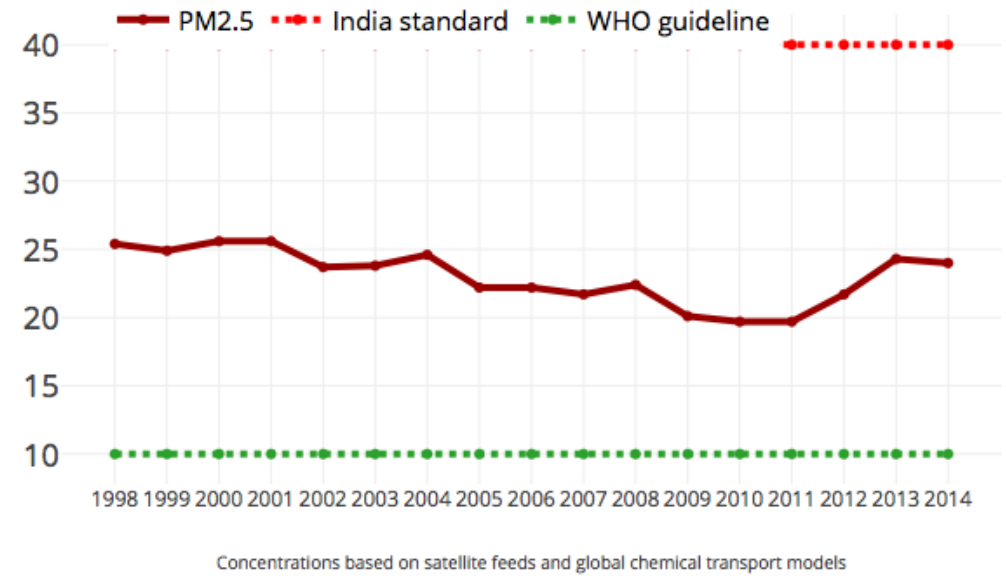


Source: Urbanemissions 2015

Satellite data

Satellite data was derived for monitoring surface PM2.5 concentration in Kochi, which was useful for evaluating trends in pollution levels and not a proxy for on-ground monitoring networks. The data was estimated using satellite feeds and global chemical transport models. The collected data were used to study the health impact of the air pollution, and it was seen that the estimated air pollution was one of the main cause of premature mortality and morbidity in India. Figure 30 shows the average ambient annual PM2.5 concentration in Kochi, which is 29.1 ± 7.6 µg/m3 – is under the national standard (40) and ~3 times the WHO guideline (10) (Urbanemissions, 2015).

Figure 30: Annual PM2.5 concentrations in Kochi µg/m³ for the period 1998-2014

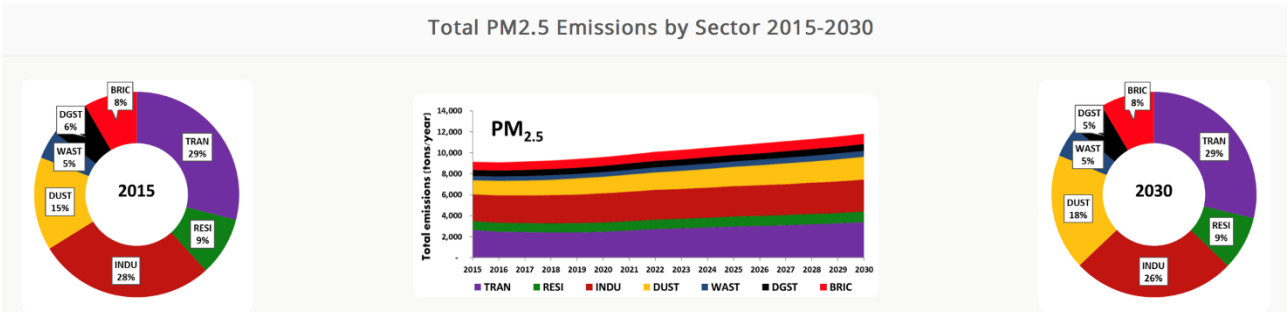


Source: Urbanemissions 2015

Emission inventory

The study by (Urbanemissions, 2015) also carried out emission inventory based on the available local activity and fuel consumption estimates in the city and does not include natural emission sources (like dust storms, lighting) and seasonal open fires (agriculture and forest) for the year 2015-2030. Figure 31 shows the estimated pollutants in various sectors.

Figure 31: Total PM2.5 emissions by sector in Kochi 2015-2030



Source: Urbanemissions 2015

TRAN = transport emissions from road, rail, aviation, and shipping (for coastal cities); RESI = residential emissions from cooking, heating, and lighting activities; INDU = industrial emissions from small, medium, and heavy industries (including power generation); DUST = dust emissions from road re-suspension and construction activities; WAST = open waste burning emissions; DGST = diesel generator set emissions; BRIC = brick kiln emissions (not included in the industrial emissions)

Monitoring and inventory results

The emission monitoring and inventory from the study (Urbanemissions, 2015) also highlights the needs to aggressively promote public and non-motorized transport as part of the city's urban development plan, along with the improvement of the road infrastructure to reduce on-road dust re-suspension. Kochi, being the port city, freight management program can reduce the footprint of emissions from these heavy duty and light duty vehicles, and associated port activities. Likewise, a technology upgrade in the city's brick kiln will improve their overall energy efficiency, and the city needs stricter regulations for addressing open waste burning in order to air pollution.

Recommendations for air pollution reduction

Transport

The city needs to promote public, shared and non-motorized transport as part of the city's urban development plan, along with the improvement of the road infrastructure to reduce on-road dust re-suspension. Bringing in city vehicles powered by less polluting fuel or electric vehicle support air pollution reduction drastically. Due to the presence of a large commercial port, the freight movement in and out on the city roads is high, which also leads to emissions from vehicles not registered in the city or the state. Kochi needs freight management program to reduce the footprint of emissions from these heavy duty and light duty vehicles, and associated port activities (Urbanemissions, 2015).

Industry

The 250 brick kilns in the urban airshed in Kochi are driven mostly by coal, agri-waste, ship bunker fuel, and other biomass. These kilns require an efficient technology upgrade from the current fixed chimney and clamp style baking to (for example) zig-zag, in order to improve their overall energy efficiency and air quality (Urbanemissions, 2015).

Garbage burning

Open waste burning is dispersed in the city, which requires stricter regulations for addressing the issue, as the city generates ever more garbage, with limited capacity to sort and dispose of it (Urbanemissions, 2015).

19.5 Spotlight: Solid Waste Management

As Kochi is a part of national missions, such as Smart Cities mission and Swachh Bharat (Clean India) mission, and state rule – Kerala State Pollution Control Board, Kochi has plans for solid waste management to keep the city clean. The corporation of Kochi is responsible for the municipal solid waste management of the city, which has two departments - Health Department and Engineering Department. The health department collects, transport and dispose waste while the Engineering Department assists them in planning, formulation of programs and in procurement of vehicles, equipment and developing site. The corporation collects and treats biodegradable and non-biodegradable waste separately (Solid Waste Management in Cochin, India: Practices, Challenges and Solutions, 2016).

Waste source, collection and treatment

Municipal solid waste includes commercial and residential waste generated in the city. Considering a significant share of waste stream from residential sector, (Landfill sites, solid waste management and people's resistance: a study of two municipal corporations in Kerala, 2017) has carried out a study on biodegradable and non-biodegradable waste by households in Kochi. The proportion of household waste in municipal waste is 55%. The city generates waste of 600 MT/day, which is 0.4 kg per capita (Landfill sites, solid waste management and people's resistance: a study of two municipal corporations in Kerala, 2017).

The study (with a questionnaire survey for 500 samples) in Kochi showed that paper waste constitutes 2.6%, glass 5.1%, metal 10.5%, organic 80.1% and plastic 1.9% of the total waste (Waste Footprint of Kochi City, Kerala - An Analysis, 2016). The analysis of ecological footprint of waste generation in the residential areas of Kochi city showed that present trend of waste generation and an assumed population growth rate of 4.5% as per the census studies, by 2051 the population will need about the full area of the city to dispose the generated waste (Waste Footprint of Kochi City, Kerala - An Analysis, 2016) (if any alternative measure has not been taken, see Table 24). This highlighted out the highly unsustainability dilemma existing in the residential areas of Kochi city in the case of waste management.

Table 25: Land requirement for waste management of the city

Year	Population	Waste footprint per person	Area (hectares required for the total population)
2001	595575	0.0129	7674.6
2011	601574	0.0129	7751.9
2021	628645	0.0129	8100.7
2031	656934	0.0129	8465.2
2041	686496	0.0129	8846.2
2051	717388	0.0129	9244.3
2061	749671	0.0129	9660.3
2071	783406	0.0129	10095.0

Year	Population	Waste footprint per person	Area (hectares required for the total population)
2081	818659	0.0129	10549.2

Source: Ravi & Vishnudas 2016

Waste segregation and collection

Since 2008, it is a mandatory to segregate waste at source in Kochi and defaulter can be fined depending on quantum and quality of waste (GIZ, 2018). However, the primary survey in (Landfill sites, solid waste management and people's resistance: a study of two municipal corporations in Kerala, 2017) shows that 42.5% households in Kochi store both bio-degradable and non-bio degradable waste in a single bin. The households are engaged in three types of waste removal practices. They are (1) household treatment of waste (composting or burning); (2) using Self-Help Group (Kudumbashree/ Sevanasree) services to remove waste, and (3) discarding on the street (Table 26). In the same survey, it shows that only 20–25% of all the households treated their biodegradable waste at home. In Kochi, the sample households mostly takes the support from Kudumbashree – an agency for the empowerment of women – for removal of both bio-degradable and non-biodegradable waste, which is available only in 15 of 71 wards in Kochi. There is a high chance that waste will be discarded on the streets in the parts of the city where the service is not available.

Table 26: Waste storage and disposal by households in sample area (%) in Kochi

Waste treatment	Biodegradable waste collection and disposal	Collection and disposal of recyclable wastes
Home treatment	20.0	20.0
Dependent on self-help groups (Kudumbashree)	52.5	52.5
Discard on the street	27.5	27.5

Source: Ganesan, 2017

In Kochi, 220 tons (out of 600 tons) were collected and transported to the treatment plant per day per population.

Waste treatment

The waste treatment facility in Kochi Corporation is in Brahmapuram, with an area of about 106 acres. The plant treats bio-degradable wastes and all the other waste, including plastic and sanitary is being dumped outside the plant. Brahmapuran plants treats 220 tons biodegradable waste and receives 72 tons non-biodegradable waste on an average on a daily basis (Solid Waste Management in Cochin, India: Practices, Challenges and Solutions, 2016). The compost produced from the plant are either sold to farmers or used by the corporation for city gardens. KMC is also planning to convert waste to energy. The corporation has started implementing decentralised waste management system, together with private partners such as CREDAI. The waste generated in the apartment complexes are composted at source through the bio-digester (using eco-friendly aerobic microbial composting system). 480 tons of solid waste is processed monthly and this has reduced the burden to the corporation to manage waste (GIZ, 2018).

Waste reduction potential

The collaborative effort of Kochi municipal corporation has led to achieve source segregation and significantly reduced the overall waste transferred to landfills. The city still needs an effort on reducing the waste volume and raise awareness on waste management (GIZ, 2018).

Recycling

The analysis carried out by (Waste Footprint of Kochi City, Kerala - An Analysis, 2016) showed the practice of recycling wastes in the city and a 50% reduction in paper, organic and plastic and 30% reduction in glass and metal waste generation can cause a 66.5% reduction in the waste footprint value. With the maximum optimistic level of 80% reduction in paper waste generation and 90% recycling of paper, 50% reduction in glass waste generation and with 50% recycling, 50% reduction in metal waste generation and with 60% recycling, 90% organic waste reduction and 90% recycling, 75% reduction in plastic waste and 50% recycling can reduce 91% of the present waste footprint of the city (Table 27).

Table 27: Present, targeted and projected waste reduction and recycling for various waste categories in Kochi

Waste category	Present			Targeted (%)			Projected (%)		
	Generation (kg)	Recycling	Footprint	Reduction in Generation	Recycling	Footprint	Reduction in Generation	Recycling	Footprint
Paper	0.01	0	3.26	50	60	1.18	80	90	0.38
Glass	0.03	0	2.85	30	30	1.81	50	50	1.21
Metal	0.05	0	23.35	30	30	11.68	50	60	5.02
Organic waste	0.42	0	96.76	50	50	27.33	90	90	4.62
Plastic	0.01	0	2.64	50	50	1.09	75	50	0.43
Total	128.86			43.09			11.66		

Source: Ravi & Vishnudas 2016

The study (Waste Footprint of Kochi City, Kerala - An Analysis, 2016) also highlighted that the waste reduction practices especially for organic waste and paper and the options for recycling can reduce the waste footprint of the residential areas of Kochi City to a considerable extent. Therefore, actions on organic waste reduction and recycling techniques should be encouraged in the city.

Need of awareness raising

As many citizens and other stakeholders are still not awareness of the importance of waste segregation and management as well as the implementation of waste management rules, public-led awareness raising programs need to be organized.

20 Case Study: Beijing, China

Beijing is the capital of China. It is located in northern China and within the Chinese cold climate zone. The city has a population of more than 21 million. Beijing has experienced rapid economic growth in the last decades. In 2018, the per capita GDP reached more than 20,000 USD (Xinhua, 2018).

20.1 Urban environmental protection challenges

Air pollution

Beijing's rapid urbanisation, industrialization and motorization have resulted in deterioration of environment, especially, air quality. In January 2013, Beijing experienced smog episodes with real-time PM2.5 levels exceeding 1,000 µg/m3 (an average annual concentration of 10 µg/m^3 PM2.5 is regarded to be unsafe by WHO). Since then, the Beijing government has made significant efforts and implemented various control measures to improve its air quality. Ever since, the concentrations of CO (carbon monoxide), SO_2 (sulphur dioxide), PM2.5 and PM10 have constantly declined (UNEP 2016). In 2018, the annual average PM concentration decreased to 51 µg/m^3. According to the monitoring result of 2017, two thirds of Beijing's annual PM2.5 concentration was local pollution, among which transport (45%), fugitive dust (16%), industrial processes(12%), and residential non-point sources (12%) are the top contributors (UN Environment, 2019).

Climate change and its effects

Liu and Cai (2018) calculated carbon emissions of 288 Chinese cities, among which Beijing city with 116.58 million metric tons ranks among the top CO_2 emitters. Energy conversion, transport, and industry are the major contributors(Liu 2018).

Under global warming, the annual average air temperature in Beijing had an increasing tendency of 1.7 degrees Celsius annually. This trend is expected to intensify in the future. The annual precipitation in Beijing showed a decreased tendency in in the last decades. Additionally, the fluctuation intensity of precipitation between urban and rural areas has increased the risk of flood and drought in Beijing area. The increased temperatures and drier summers have increased water stress and will amplify in the future in Beijing (Biao 2011).

Water pollution and availability

Beijing is currently facing severe water shortage due to intense urbanisation and overexploitation of its natural water resources. Climate change has additionally contributed to water stress (Wang et al. 2015). In order to satisfy industrial and residential demands, Beijing has heavily relied on groundwater, which caused aquifers depletion and land subsidence. Beijing's primary source of surface and groundwater is precipitation. Since climate has become warmer and drier, precipitation has also gradually decreased. As a result, in 2014, fresh water resources reached only 145m^3/capita per year (Ritter, 2018). At the same time, according to the newest water quality report of Green Peace Asia, 40% of Beijing's total water surface was graded worse than grade V, which is only suitable for agricultural and landscape use (Boren, 2017).

Soil pollution

The contamination of soil has emerged as an environmental concern in China due to the unprecedented rates of urbanisation in the last decades but remains nonetheless the most neglected threat to public health (The Economist, 2017). Beijing's urban soil has shown exceeding levels of contamination as many other urban areas in China. The green space soil of Beijing showed moderate to severe levels of heavy metal pollution originating from vehicular

transport, industrial activities, phosphate fertilisers and parent materials (Lin, 2017). Soil heavy metal pollution can largely affect the health of residents, and qualitative data on this behalf is crucially important for sustainable urban planning.

Waste generation and management

Beijing's economic development and population growth have resulted in a municipal solid waste generation higher than all major cities in China (Jinran, 2016). In 2017 alone, the residents of Beijing produced over 9 million tons of domestic garbage and the amount was expected to rise. Currently, 30 % of the neighbourhoods in Beijing are sorting domestic garbage and incentives are needed to further promote and stabilize this trend (Liu et al. 2015, Birtles 2018). 40% of the city's domestic waste is discarded into landfill sites. The rest is burned or biochemically treated. The capacity of the existing disposal plants cannot cope with the actual quantity of waste generation, resulting in overloading and premature closure of landfill sites (Birtles, 2018). Thus, informal landfills emerged for waste that could not be managed by the existing infrastructure (Pla, 2015).

Biodiversity

Beijing city has a high biodiversity, which includes 2261 plant species (in 171 families and 972 genera), 2129 angiosperm species (in 144 families 922 genera),435 species of wild birds. Similar as other large cities in China, due to the rapid urbanisation, its forest ecosystems area had decreased, but moderately (decreased by 136.03 km^2 between 1993 and 2013), most of which was converted to construction land (Xiao 2015).

20.2 Cross-sectoral policies and measures to protect the urban environment

Beijing city have progressively taken sectoral and cross-sectoral actions on environmental protection. Same as national government, every five years, municipal governments issue Five-Year Plans (FYPs) of overall economic and social development as well as specific fields such as environmental protection, climate action, energy efficiency, and energy supply. The 13th environmental protection FYP (2016-2020) of Beijing sets targets for water, air, soil protection as well as solid wastes and specifies measures in different sectors to achieve the targets, ranging from the transport, energy supply and use, industry, infrastructure and construction, agriculture, to service sector. Measures include, for example, clean energy, prioritising public transport, closing down high-energy-use and pollution-emitting industries, dust controlling at construction sites, and nitrogen pollution control for agriculture practice. Besides, the municipal government also issued 13th FYP of energy efficiency and climate action, which aims to peak its CO_2 emission and achieve a 17% of energy intensity reduction by 2020 as well as an enhancement of climate adaptation. The plan requires actions from all sectors. In addition, the 13th municipal FYP of energy supply aims to limit energy consumption below 76million ton of coal equivalent(tce) and an 8% of renewable energy in end use by 2020. To achieve both energy efficiency and renewable goals, the building, transport, industry, and energy sector have received high attention. Furthermore, due to the severe air pollution, Beijing city issued the Five-Year Clean Air Action Plan (2013-2017)" in 2013 and "Three-Year Action Plan for Blue Sky" in 2018, which calls for sectoral and cross-sectoral efforts, especially, the transport, energy supply, industry, and construction sector. To promote cross-sectoral collaboration, the municipal government established air pollution prevention and control leading group led by the mayor.

20.3 Overview of activities in different fields

The following sections provide a brief overview of the most important policies and measures in different fields.

Air pollution

To improve air quality, the municipal government has issued a Five-Year Clean Air Action Plan (2013-2017) in 2013 and Three-Year Action Plan for Blue Sky in 2018. These plans set stringent targets, specify measures covering different sectors, and include comprehensive monitoring system. The implementation of first Action Plan had successfully and significantly reduced air pollution in Beijing.

Climate change and its effects

Beijing is a member of China's Alliance of Pioneer Peaking Cities (APPC) and has pledged to peak its CO_2 emission by 2020 (IGDP, 2015). By 2020, Beijing City aims to reduce its annual energy consumption to 76.5 million tce (International Platform of City Carbon Peak, 2018; Beijing Government, 2016).

Various measures of air pollution control and prevention taken by Beijing government have at the same reduced CO_2 emission. Especially, stringent measures have significantly reduced CO_2 emission from the industry. Besides, the building sector is a key area of city's efforts in energy efficiency and climate mitigation. It becomes now the largest energy consumer in Beijing, representing 47% of the city's total energy consumption and rising (C40, n.a.). To achieve its CO_2 peak target, Beijing has developed a set of policies to improve building energy performance. For example, the city issued „Beijing Ultra-low Energy Building Development Action Plan (2016-2018)", which aims to construct not less than 300,000 m^2 of ultra-low energy buildings in three years. Accordingly, a series of demonstration projects were implemented with subsidies and guidelines and standards for different types of buildings were developed.

Water pollution and access to water

To deal with the severe water scarcity in the city, Beijing has implemented a set of strategies and policies to stimulate water conservation and pollution, for example, the Most Stringent Water Resource Management issued by the central government in 2012, promoting water-saving society, and introducing market-based policy instruments. Besides, the city has also promoted the use of alternative water resource for residential areas in the suburbs and new towns as well as for wetland conservation.

Waste generation and management

During 13th Five Year Plan period (2016-2020), Beijing aims to reach daily waste treatment of 30,000 ton, household wastes utilization rate of 60%, wastes recycling rate of 35%, nearly zero landfill. To achieve these targets, Beijing government has made significant efforts in solid waste management, through both issuing policies and improving infrastructure. For example, the city has mandated household waste sorting (GOV, 2016). Besides, new waste incineration plants that fulfil environmental standards and food waste treatment plants are being built. The daily food waste treatment capacity shall reach 3000 ton, being twice as the current level (Beijing Government, 2017a).

Soil pollution

In 2018, Beijing municipal government issued an Action Plan to prevent and control soil contamination. According to the Plan, the soil quality will be stabilized and brought to the safe levels by 2020. Major measures taken by the municipal government include status survey of

current soil environment and pollution risks of farmland and industrial land, enhancing prevention and source control, strengthening monitoring, and mandating ex-ante assessment for key projects and risk assessment for brownfield development (Beijing Government, 2017a).

Biodiversity

In 2019, Beijing city announced a plan to develop six biodiversity restoration pilot areas that covers urban green space, forest, and wetland. The municipal government is supporting a comprehensive study on status quo of Beijing biodiversity and restoration strategy. Furthermore, a series of afforestation actions have been implemented (Forest Gov, 2019). Until 2018, afforestation rate and green space coverage reached 43.5% and 48.4%, respectively (GOV,2019).

20.4 Spotlight: Air pollution reduction

Eight months after the haze pollution episodes, State Council released its Action Plan for Air Pollution Prevention and Control in September 2013, which set the roadmap for air pollution and control for the next five years in China focusing on three key regions – Beijing-Tianjin-Hebei area (Jing-Jin-Ji), Yangtze River Delta (YRD) and Pearl River Delta (PRD). In Jing-Jin-Ji, the National Plan targeted at an annual average concentration of PM2.5 below 60 µg/ m^3 and a 25% reduction compared to the level of 2012 (State Council, 2013). In response to the National Plan, Beijing City had made tremendous efforts to improve its air quality. The municipal government issued a „Five-Year Clean Air Action Plan (2013-2017)“ with targets in line with the National Plan. To realize this goal, about 60 measures of air pollution prevention and control were implemented in energy, transport, and industry sectors (Beijing Government, 2013).

- Energy supply: The Action Plan targets at a coal consumption reductions of 13 million tons compared to the level of 2012 by e.g. closing down coal-fired power units, replacing coal with clean energy for household and industrial heat supply in city centre and key industry parks in suburban areas, accelerating clean energy development in rural area, promoting natural gas-fired combined heat and power plants (CHP), etc.

- Transport: The Action Plan aimed to restrict the total number of vehicles to around 6 million by the end of 2017 and to create a green transport system. To achieve this goal, Beijing government had implemented various measures, such as controlling total vehicle population within 6 million by 2017, prioritising public transport (e.g. improving BRT system and accelerating construction of metro systems), promoting the use of clean energy in public buses and taxi, public service vehicles, limiting vehicle license plates using a lottery system, tightening vehicle emission standards, conducting research on various incentive systems such as increasing operational costs of motorized vehicles, charging congestion fee, differentiated parking fees.

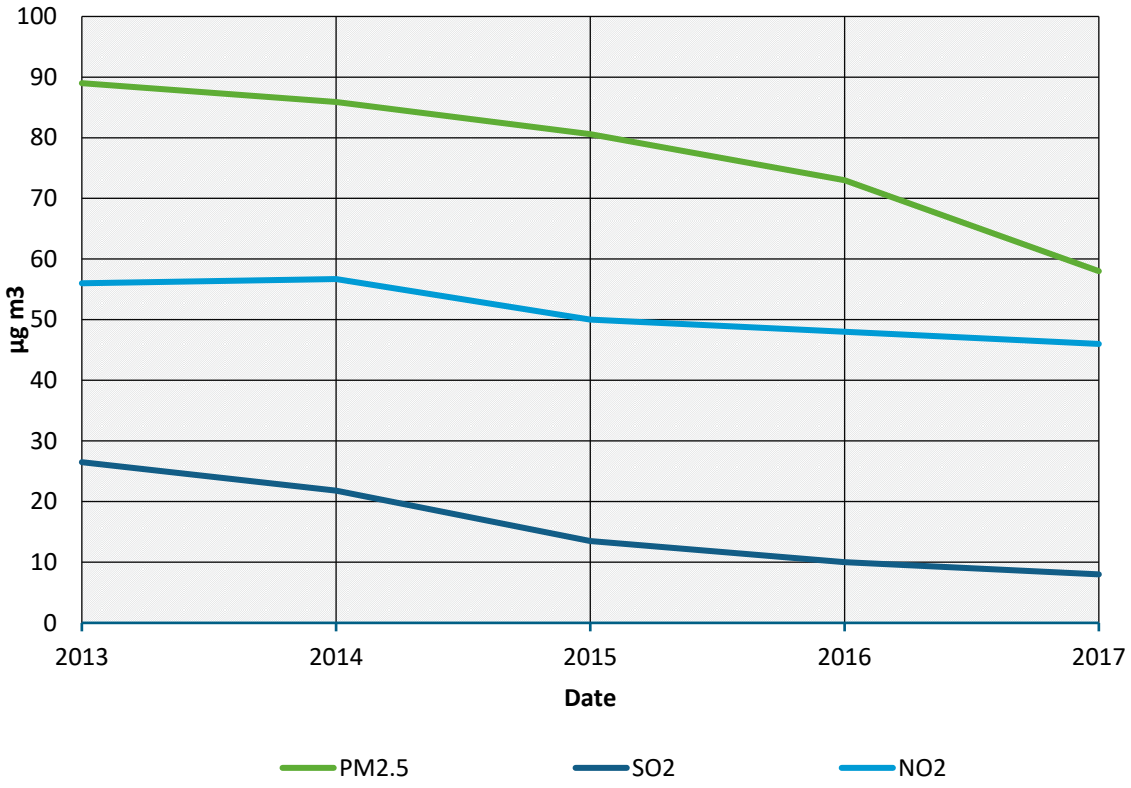
- Industry: The Action Plan aimed to close down high-energy-use and pollution-emitting industries or relocate them outside of the cities (1200 factories until 2016), significantly improve the prevention and control of industrial pollution, decreasing production capacity of cement plants, strengthen environmental assessment of new industry sites, tighten the air emission standards of specific industries (e.g. power generation, building material manufacture, furniture manufacture), promote cleaner production, introducing fiscal and financial incentives, and strengthen monitoring and sanction.

The total investment for air pollution prevention and control was amounted to about 5 trillion Yuan (about 666 billion EUR) (Xinhua, 2017). The implementation of the Action Plan (2013-2017) had significantly improved the air quality of the city and resulted in PM 2.5 concentration

of 58 µg/m³ (a 34.5% reduction compared to 2013) and 226 days with good air quality in total (50 days more than that of 2013) (Beijing Government, 2018a).

In 2017 and 2018, Beijing government further increased public budget in this field, which was more than 35 billion Yuan in total (about 4.7 billion EUR) (GOV, 2018a). In 13th Five Year Plan period (2016-2020), construction dust controlling also becomes a key measure taken by the municipal government to improve air quality. For example, real-time monitoring systems were installed on construction sites. high pollution charge was imposed to construction projects emitting significant dust. Besides, the government has promoted pre-fabricated construction and aims to reach more than 30% in the total new construction.

Figure 32: Annual average pollutants in Beijing, 2013-2018



Source: Beijing Environmental Report 2018, own illustration, Wuppertal Institute

In 2018, Beijing government issued the "Three-Year Action Plan for Blue Sky ", which aims to reduce the concentration of Nitrogen Oxide (NOx) and Volatile Organic Compound (VOC) by 30% and number of severe pollution days by more than 25%, compared to the level of 2015 (Beijing Government, 2018b). To achieve the objectives, the Action Plan takes a cross-sectoral approach, among others:

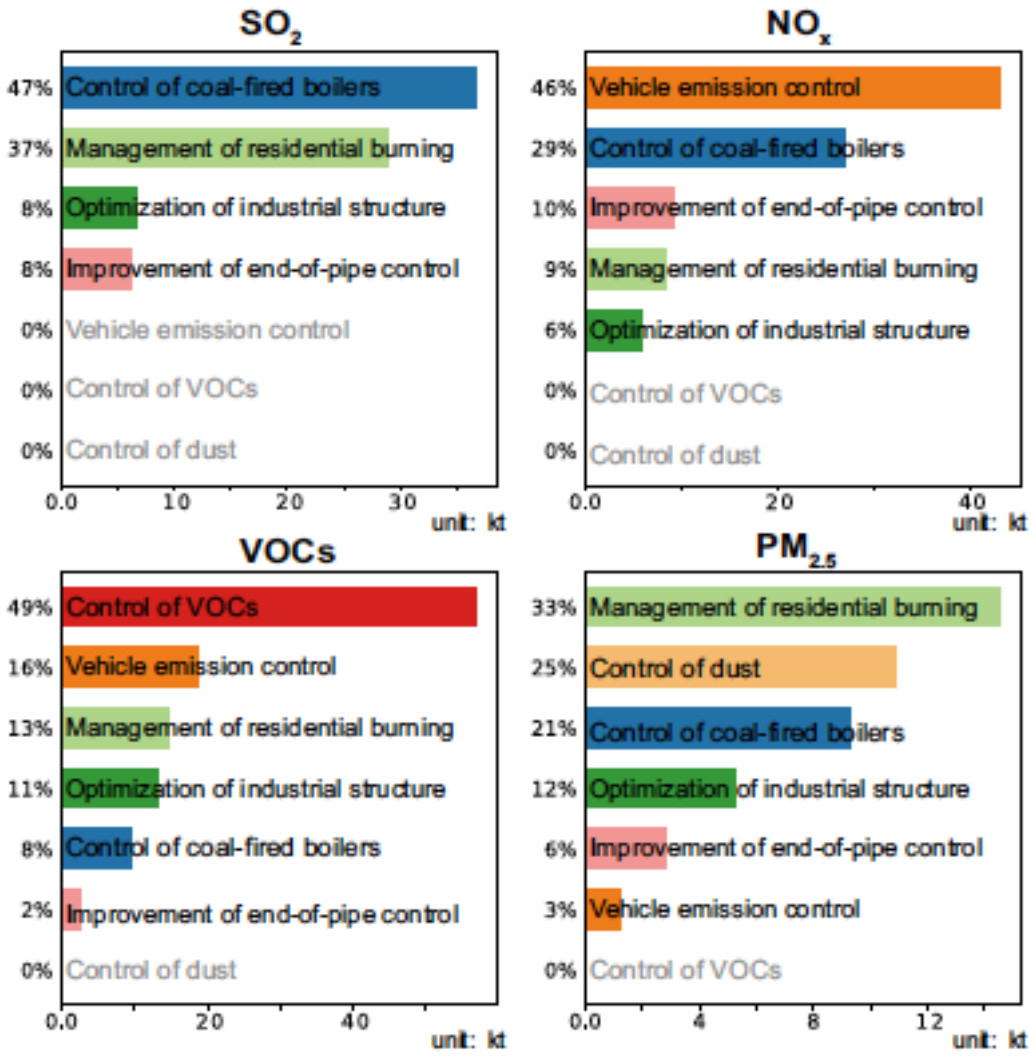
- Transport-related pollution shall decrease by 30%, compared to the level of 2017;
- Construction dust shall decrease by 30%, compared to the level of 2017;
- Adjusting the economic structure and promote green industry growth;
- The share of clean energy shall increase to 95% by 2020;
- Preventing air pollution in construction, food, and automobile service sector.

Outcomes

Three main types of air pollutants in the period of 2003-2018 are used as indicators, namely PM2.5, NO_2, and SO_2 (Figure 32).

According to Beijing annual environmental reports, PM2.5 pollution has decreased rapidly by 74% from 2013 to 2018. Replacing coal with clean energy for household heating, reduction of construction dust, and control of coal-fired power plants were the three key measures contributing to the reduction. NO_2 pollution has decreased by 33% from 2013 to 2018. Since 2015, the NO_2 levels have only been slightly higher than that of the national standards (about 5-15% higher), compared to more than 40% in 2013 and 2014. Municipal efforts to control vehicle emissions and eliminate coal-fired boilers played an important role here. SO_2 level in the city has reduced significantly by more than 340%, which was mainly attributed to eliminating coal-fired

Figure 33: Emission reduction and relative contributions of each control measure in Beijing during 2013-2017



(a)

boilers and replacing coal with clean energy for household heating (UN Environment, 2019).

Source: Chen et al. 2019

20.5 Spotlight: Water management

Given the severe water scarcity in the city, Beijing has implemented a set of policies to stimulate water conservation and prevent water pollution. Since 2013, Beijing has implemented the "Most Stringent Water Resource Management" issued by the central government in 2012, which set stringent limits of water resource exploitation, water use, and water quality. By 2015, the annual total water consumption was limited to four billion m^3; water use intensity shall not be lower than 18m^3 per 10000 Yuan of GDP; more than 60% of key reservoirs, rivers, and lakes reaches water quality standards (Beijing Government, 2017b). These targets were binding and included as a criterion in the cadre evaluation system of local officers. After successfully accomplishing the targets, Beijing government has further committed to sustainable water management in the 13th Five Year Plan period (2016-2020). By 2020, Beijing will establish a comprehensive water saving society system: the total water consumption shall be lower than 4.3 billion m^3; the use of reclaimed water shall reach 1.2 billion m^3; wastewater treatment rate shall reach more than 95%; 77% of key reservoirs, rivers, and lakes shall reach water quality standards; daily wastewater treatment capacity shall reach 7.26 million m^3(Beijing Government, 2017a). In 2018, the municipal government has set higher water quality target, i.e. more than 95% of the key functional zones shall reach water quality standards by 2035 (People Daily, 2018).

To reach water use efficiency targets, not only command-and-control (as described above) but also market-based instruments have been implemented. Water use quota system has been stipulated for different administrative districts and key sectors. Since 2014, Beijing government introduced progressive water resource fee system, in which water intensive users need to pay a higher charge if they consume beyond a certain threshold (Gov, 2014). In 2018, Beijing was designated as a pilot city of water resource tax reform by the central government. The national pilot program was launched in 2016 to replace water resource fee system with tax, starting in one northern China province and expanding to additional nine provinces and cities. The new system is not expect to increase economic burden on normal residential water use. To promote water saving, similar as water fee system, the tax system imposes higher tax on water intensive users (e.g. car washing, spa, golf) and exploitation of groundwater. Tax for excessive water consumption is between 2-3 times as much as the basic tax. Besides, Groundwater use tax is about three times as that of surface water. The system encourages water-saving activities and the use of reclaimed water by reducing tax or tax exemption (GOV, 2018b).

The city has promoted the exploitation of alternative water resource, for instance, reclaimed wastewater. Since 2003, reclaimed wastewater has been supplied for residential use in the suburbs and new towns as well as for wetland conservation. In 2018, reclaimed water reached 1 billion m^3, which was 25% of total water supply in the city (BJNews,2018). The government has encouraged exploration of PPP models on financing, operating, and maintaining reclaimed wastewater projects.

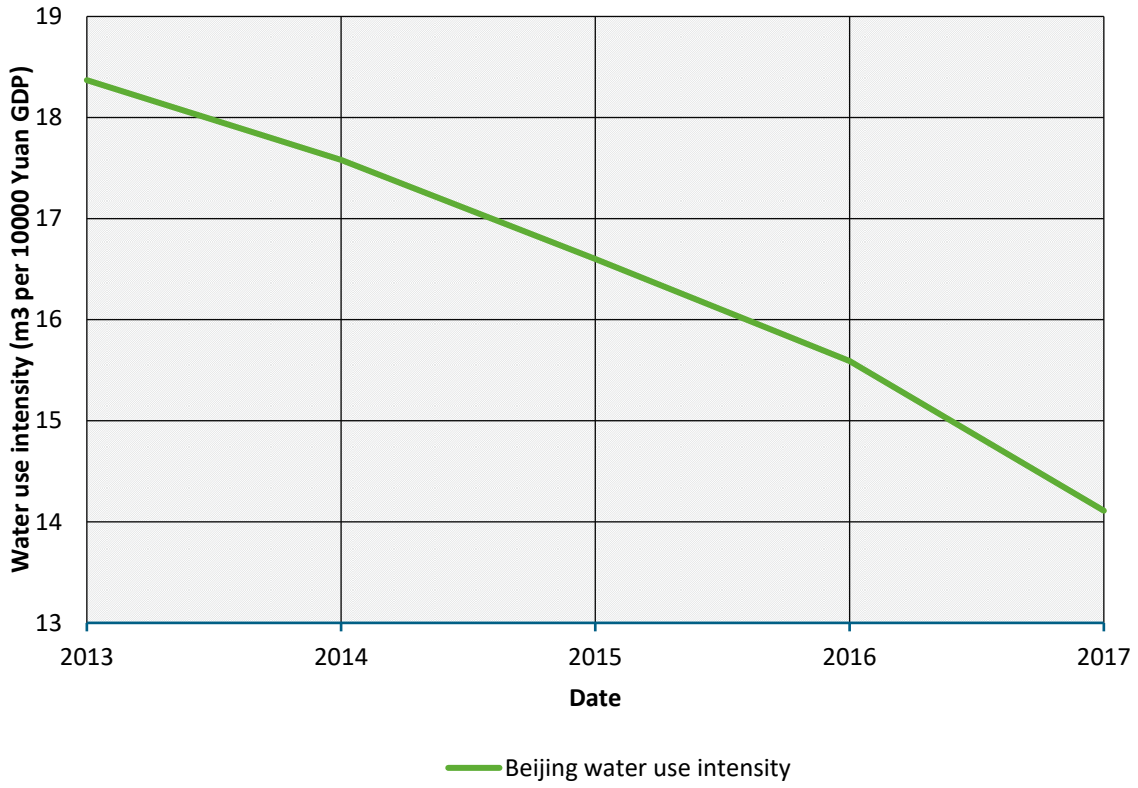
To improve water quality, similar as national government, Beijing government has been largely rely on building required infrastructure and strengthening monitoring and enforcement mechanisms. By 2020, Beijing will construct or expand 44 wastewater treatment plants or reclaimed water plants. In total, 1347km wastewater pipelines will be built and retrofitted. Besides, Beijing government also has imposed strict control on pollution source: 1) controlling water pollution from agriculture through, e.g. limiting new construction of large-scale livestock farm, encouraging the reduction of fertiliser and pesticide application; 2) strictly enforcing

industrial wastewater management through, e.g. stopping high pollution industrial projects, real-time monitoring, etc. (Beijing Government, 2017a).

Outcomes

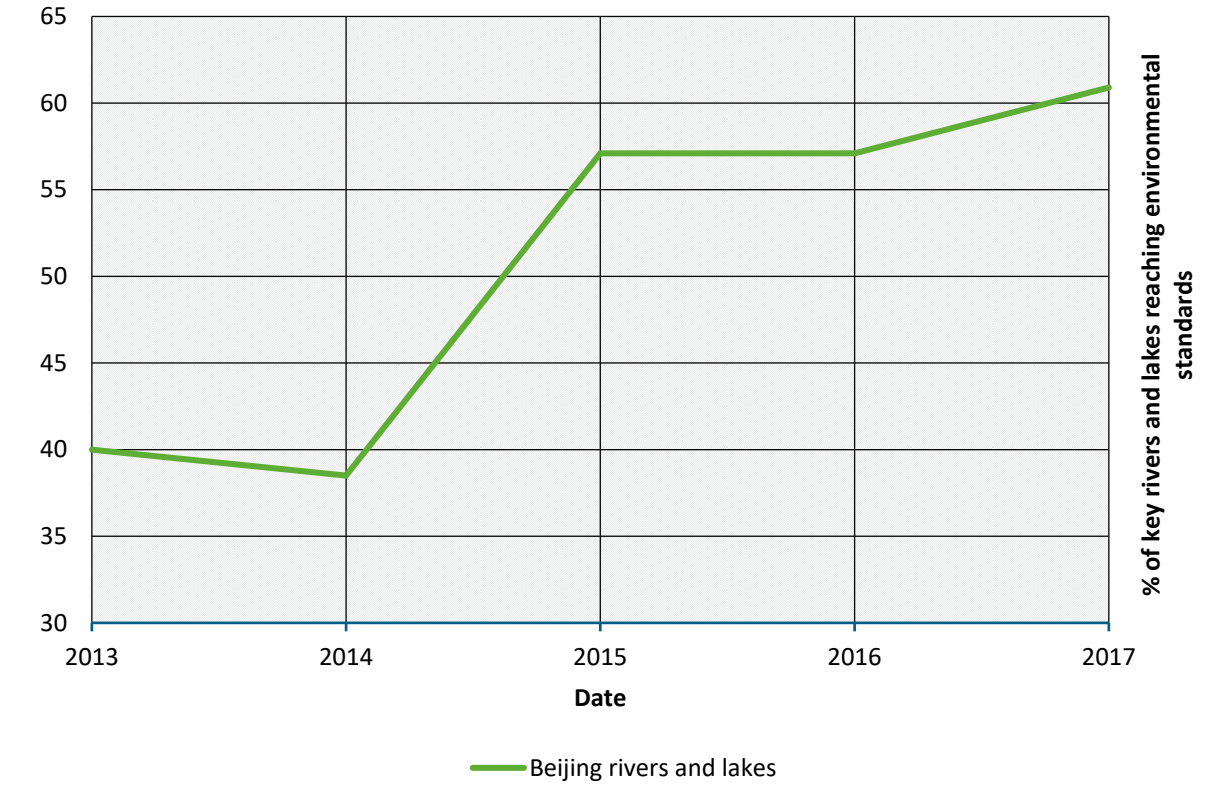
As a result of the implementation of various policies, Beijing annual environmental reports show that, since 2013, the water use intensity of the city has decreased by 23%, reaching 14 m^3 per 10000Yuan GDP in 2017 (Figure 34). At the same time, water quality has also been improved significantly, key rivers and lakes reaching environmental standards accounted for 61% of the whole water body, has increased by 52% since 2013 (Figure 35). Furthermore, water use for the ecosystem has received increasing attention and reached 1217 million m^3 in 2017, which was 71% higher than 2013 (Figure 36). The city has made its efforts in reusing water. The reused water was amounted to more than 1 million m^3 in 2017 (Figure 37).

Figure 34: Water use intensity, 2013-2017



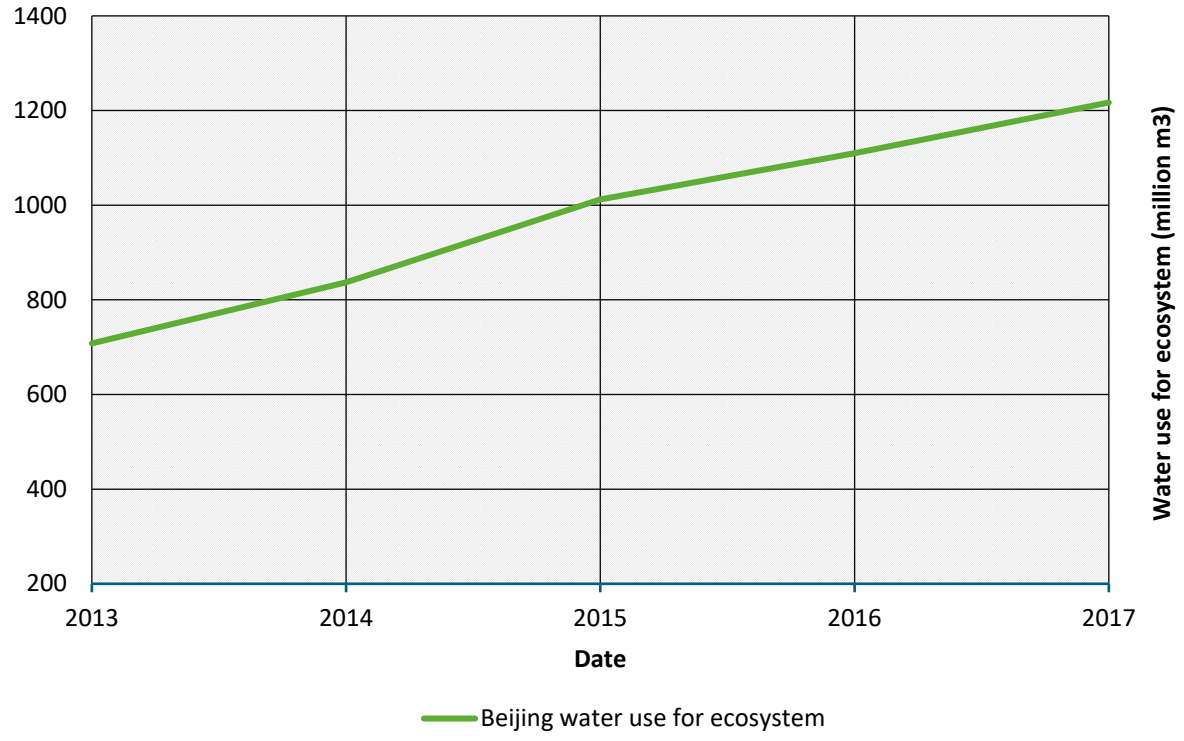
Source: Beijing Environmental Protection Bureau

Figure 35: Percentage of key rivers and lakes reaching environmental standards, 2013-2017



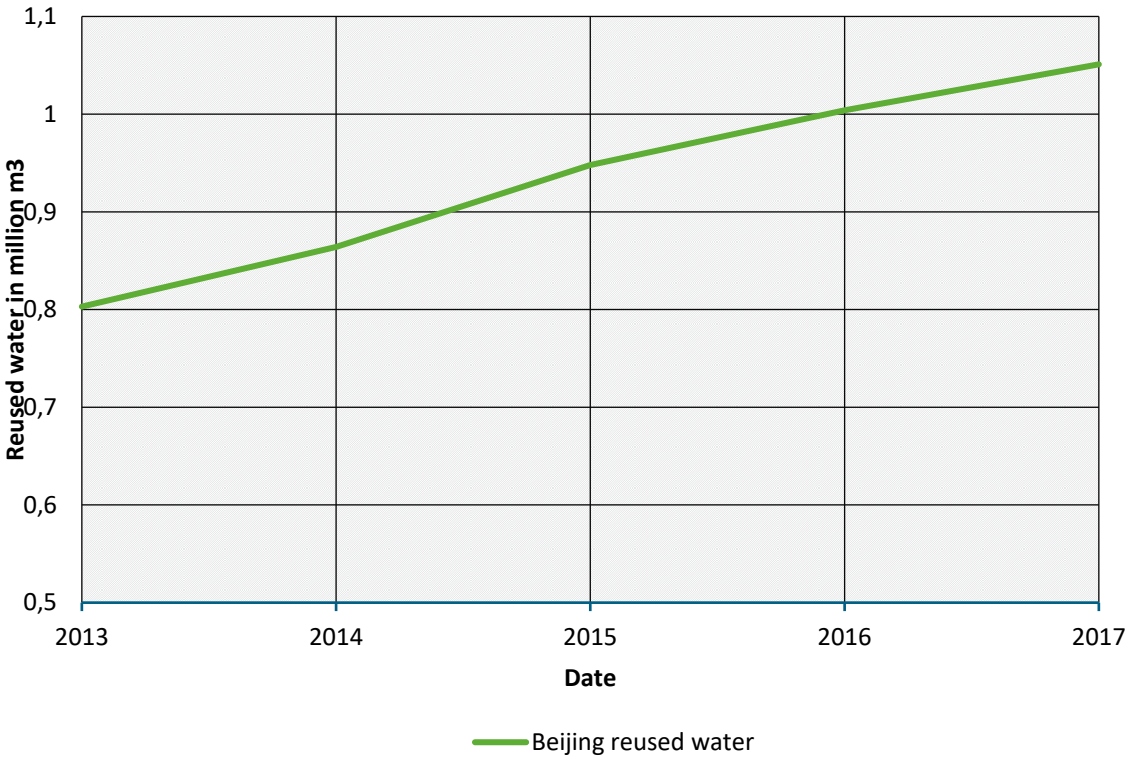
Source: Beijing Environmental Protection Bureau

Figure 36: Water use for ecosystem, 2013-2017



Source: Beijing Environmental Protection Bureau

Figure 37: Reused water, 2013-2017



Source: Beijing Environmental Protection Bureau

21 Case Study: Cape Town, South Africa

Cape Town is the legislative capital of South Africa and capital of the Western Cape province. It forms part of the City of Cape Town metropolitan municipality, which executes all the functions of local government. The City of Cape Town Metropolitan Municipality is home of 4.005 million inhabitants on an area of 2,446 km², which translates into a population density of 1,638 inhabitants per km² (data from 2017, Statistics South Africa 2017). Cape Town Municipality is governed by a 221-member city council. The Executive Mayor and Executive Deputy Mayor are elected by the city council.

Cape Town is a main economic centre for South Africa. Because of its mild climate and natural setting, it is also a popular international tourist destination.

21.1 Urban environmental protection challenges

Cape Town faces challenges brought about by urbanisation. Within the realm of environmental prosperity, Cape Town must combat water and air quality degradation, the functionality of ecosystems, the conservation of critically endangered vegetation (11 of the 21 nationally critically endangered vegetation types are found in the municipal boundaries of Cape Town, Van der Merwe 2015), and the looming effects of climate change.

Air pollution

The main sources of ambient air pollution in the Cape Town Metropolitan area are NO_2, particulate matter and SO_2 emitted by industry, vehicles, electricity generation and domestic fuel use (heating and cooking). Indoor air pollution levels are also reportedly high, despite widespread electrification in the City (StatsSA 2016). A significant number of households utilize domestic fuels such as gas, wood and paraffin for heating and cooking. The 2016 community survey reveals that approximately 2% of lighting needs, 9% of cooking needs and 14% of heating needs are powered by alternative fuel sources (ibid.).

Climate Change and its effects

Cape Town has a higher carbon footprint than national average (5.55 tCO_2/capita, 4th of 8 metropolitan regions in South Africa), which results from its fossil fuel-based energy supply: the commercial and residential sectors almost exclusively use coal-power generated electricity. Transport fuel consumption is growing and can be attributed to the city's sprawling urban form and high average commuter trip length with a high proportion of the private car. Currently 53% of commuter trips are by private vehicle (City of Cape Town 2017).

Effects of climate change lead to concerns regarding food, energy and water security in the city (City of Cape Town 2012).

Water pollution and access to water

Water is a scarce resource in the city, severe droughts have brought about an ongoing water crisis in the recent past. Every summer can become an environmental and social disaster because of lack of (potable) water (Enquist & Ziervogel 2019).

In principal, the city provides access to water and sanitation services for all residents, in line with national government's policy. Formal properties receive services through a metered connection, while informal settlement households receive free and unrestricted services via communal water points. All households in Cape Town are equipped with water supply that complies with national norms and service standards. Cape Town receives 98 percent of its potable municipal water from a large and sophisticated system of mountain-fed dams extending

into the regional hinterland. However, the backwater system may fall dry during the rainless periods (ibid.).

Desertification and land degradation

There are concerns that the water scarcity, which leads to extensive drilling in the region, put both the unique biodiversity of the region and the aquifer's long-term sustainability at risk. For instance, some of the aquifers, where groundwater is taken from during the droughts, may not be rechargeable (Slingsby et al. 2018).

Waste generation and management

One key driver for the increase in household waste generation in the Western Cape is population growth. Cape Town is the region's central hub for commerce and industry. However, the city only generates a share of 26% (951 600 tons) of the total commercial and industrial waste (including agriculture in the region, i.e. non- household waste. This is because primary agriculture is located outside the city and agricultural residues account for 28% (2 million tons) of the overall waste generated in the Western Cape (GreenCape 2018).

Loss of biodiversity

The Cape floral region is one of the most botanically diverse areas on earth. Its biodiversity is, however, at risk due to challenges such as water scarcity and urban growth (Slingsby et al. 2018).

21.2 Cross-sectoral policies and measures to protect the urban environment

The City of Cape Town has sought to be proactive in addressing issues of environmental protection. In 2001, Cape Town became the first city in Africa to approve and adopt a comprehensive city-wide environmental policy: the Integrated Metropolitan Environmental Policy (IMEP). The IMEP set out the city's environmental commitments and the policy was accompanied by a series of strategies and plans that outlined specific steps for achieving sectoral goals. Most recently in 2014, Cape Town actively worked towards the city's designation as the first metro bioregion in South Africa. This bioregion is planned to cover a metropolitan area of 2,460 km^2. The Cape Town Bioregional Plan, through which the declaration will be drafted, is a spatial plan that will showcase terrestrial and aquatic features that are critical for conserving biodiversity and maintaining ecological functioning. The implications of this will be that issues of biodiversity and ecological management will be considered within development planning, placing them at the forefront of progress (City of Cape Town 2015).

The City is making a concerted effort to improve its resource efficiency, as well as to address factors that affect climate change. This includes climate change mitigation initiatives, improvement of air quality, the diversification of its energy mix, as well as adaptation measures such as conserving biodiversity, reducing waste to landfill, and increasing recycling. In this regard, the City has developed an „energy2040" vision and set energy goals and targets for 2020 for the residential sector, commerce, transport as well as energy generation: These are carbon emission reduction targets against a baseline. In absolute terms, the carbon dioxide emissions shall remain constant unteil 2035 and decline afterwards. Residents' and businesses' cooperation are supposed to be critical for the achievement of these targets, e.g. through vehicle fleet renewal and solar energy generation (City of Cape Town 2017).

Table 28 provides an overview of cross-sectoral, integrated policies of the City of Cape Town. Interestingly, each policy lists relevant by-laws and other policies, which are relevant to the issue. In so doing, the City points to the interdependency of different fields of activity.

Table 28: Cross-sectoral policies in Cape Town and their relation to activities in urban environmental protection

Policies	Air quality	Climate Change	water quantity	waste management	Biodiversity
Bioregional Plan for City of Cape Town		x	x	x	x
Cape Town Densification Policy		x		x	x
Climate Change Policy	x	x	x		x
Environmental Strategy Policy	x	x	x	x	
Five year integrated development plan	x	x	x	x	x
Municipal Spatial Development Framework Policy		x	x	x	x
Parks Development Policy	x	x	x	x	x
Urban Agricultural Policy	x	x	x	x	x

Source: Website City of Cape Town, own compilation, Wuppertal Institute

Sectoral Strategies, policies and by-laws

The city also stipulated a number of sectoral policies, which are named in the following (Website City of Cape Town). Each strategy may be complemented by the implementation of by-laws.

Buildings

Allocation Policy: Housing Opportunities, Proactive Re-blocking of Informal Settlements Policy, Establishment and Functioning of Community Residential Units Committees Policy, Land Use Enforcement Policy for the Planning and Building Development Management Department

Disaster Management

Disaster Risk Management Volunteer Policy, Floodplain and River Corridor Management Policy, Integrated Coastal Management Policy, Integrated Risk Management Policy, Management of Urban Stormwater Impacts Policy

Human health

Air Quality Management Plan for the City of Cape Town Policy

Transport

Cycling Strategy Policy, Fares Policy for Contracted Road-based Public Transport, Parking Policy, Provision of Road Tolls in the City of Cape Town Policy, Traffic Calming Policy, Transit Oriented Development Strategic Framework Policy, Travel Demand Management Strategy for the City of Cape Town, Travel Management Policy

Waste Management

Accreditation of Service Providers of Waste Management Services In Cape Town Policy, Integrated Waste Management Policy, Solid Waste Management Services: Framework for Service Delivery, Service Levels and Funding Options

Water Management

Sanitation Tariff Policy, Water Demand Management Policy

21.3 Overview of activities in different fields

The following sections provide a brief overview of the most important activities in different fields, taking into account the above-mentioned strategies and policies.

Air pollution

In 2005, the City adopted the Air Quality Management Plan for the City of Cape Town, and in 2010, adopted the City of Cape Town Air Quality Management Bylaw. Among other provisions, this bylaw regulates emissions of atmospheric pollutants within Cape Town, and puts in place licensing and penalty systems (as described in more detail below).

The City of Cape Town monitors air quality and compares the daily readings to internationally accepted guidelines (which are also the national standards). They provide an online air quality reading service which provides real-time air quality information and readings and summaries for the previous day. Monthly reports and annual episode reports (where pollution levels exceed the accepted guidelines) are also available.

Climate change and its effects

Cape Town's vision is „to become a city that is climate resilient, resource efficient and lower carbon, in order to enable sustainable and inclusive economic and social development, and environmental sustainability" (City of Cape Town 2017). It is intended that, over time, climate change related considerations will eventually be mainstreamed into all City policies, strategies and decision making, and therefore the need for a standalone climate change policy will be reviewed in the future.

An important milestone for the city was the adoption of the „City Development Strategy" (CDS) in 2012, which presented a vision for the city in 2040 and a set of strategies for progressing towards that vision (City of Cape Town 2012). Within the CDS, emphasis is placed on increasing the resource efficiency (food, energy and water) of the city over the medium to long-term and the need for research and innovation to support such a transition. The CDS has been replaced by the Five year integrated development plan.

To mitigate climate change, the city has implemented a range of policies and by-laws in all sectors, mainly transport and applications.

Water pollution and access to water

As water is a scarce resource, the city has issued a very ambitious programme, the Water Conservation and Water Demand Management Strategy (WCWDM programme, City of Cape Town 2007). This encompasses a number of behavioural and technical measures, including awareness raising campaigns and a number of policies and by-laws to be able to restrict water usage. For example, the City of Cape Town has developed guidelines for the collection and use of sea water for household purposes during a water crisis (City of Cape Town 2001, 2010, 2018). See spotlight below for more details.

Waste generation and management

All formal households in Cape Town receive a basic service of weekly kerbside refuse removal. Altogether, 99.74% of informal settlements have access to a door-to-door refuse collection service or ongoing area-cleaning services. The remaining 0.26% are areas reported not to be accessible to deliver the service (City of Cape Town 2017).

The City of Cape Town is continuously working to reduce the amount of waste that ends up being illegally dumped or deposited in landfills, and over the past six years the city's waste minimization initiatives have helped to steadily increase the percentage of waste diverted away

from landfills. The city hoped this would help foster a culture of responsible waste management by making it more convenient for residents to drop off waste closer to where they were situated. These new drop-off sites brought the total number of city-operated drop-offs to 24, each within a 7km radius of the next, with this distance reducing as more drop-offs were added. Members of the public could drop up to three free loads daily from a vehicle whose capacity does not exceed 1.5 tons. The daily limit of three loads applied to builders' rubble, clean garden waste (excluding tree stumps), or garage waste. Unlimited free loads of clean recyclables could also be dropped off at these facilities. This would include empty water bottles that members of the public bought during the time of extreme drought (ibid.).

Loss of biodiversity

The city's Bioregional Plan is dedicated to terrestrial ecosystems, wetlands, coastal zones; it points to major land and resource use, includes critical biodiversity areas maps and other land uses. It also includes guidelines measures for their management (City of Cape Town 2015). The purpose of the Bioregional Plan is to inform and guide planning, environmental assessment and natural resource management by a wide range of sectors whose policies and decisions impact on biodiversity. It provides a framework for all City line departments to align their environmental functions and responsibilities. The spatially explicit Biodiversity Network (CBA map) shall facilitate forward planning that minimizes impacts on biodiversity. This shall create a more integrated, cost- effective approach to environmental management and conservation in the bioregion. The intention of the Bioregional Plan is to provide critical information on biodiversity to guide forward planning and future development. It is also aligned with the National Spatial Biodiversity Assessment.

The Cape Town's Biodiversity Report from 2018, showcases a selection of many implementation tools and biodiversity projects taking place for biodiversity conservation. These range from protected area expansion mechanisms, invasive species control, ecological restoration, monitoring performance in relation to biodiversity goals, urban wildlife conflict, coastal management, caring for heritage assets in biodiversity area, environmental education to fire as a management tool (City of Cape Town 2018).

Other policies

With respect to noise pollution, the city developed a service where concerned citizens can report noise to the Environmental Health's Specialised Services for a noise disturbance, or the local Sub-district Office for a noise nuisance, who will then send someone over to measure the noise levels. Depending on the findings, further instructions will be provided for options for solving the problem (Website City of Cape Town).

21.4 Spotlight: Air pollution reduction

The South African Air Quality Act (NEM:AQA) foresees air quality management through pollution prevention and minimization at the source, and through impact management. Municipalities were granted executive authority over air pollution control within their areas of jurisdiction.

The National Ambient Air Quality Standards (NAAQS) were released in 2009 by the Department of Environmental Affairs of South Africa (see chapter 13.1). The standards contain requirements in terms of acceptable levels of pollutants permitted in ambient air. All municipalities are required to meet these national standards by developing and implementing air quality management plans.

Table 29: South African National Ambient Air Quality Standards

Pollutant	Annual Average	Daily Average
Nitrogen Dioxide (NO2)	≤ 40µg/m3	-
Sulphur Dioxide (SO2)	≤ 50µg/m3	≤ 125 µg/m3 with no more than four exceedances per monitoring station annually
Particulate Matter (PM10)	≤ 40µg/m3	≤ 75 µg/m3 with no more than four exceedances per monitoring station annually
Particulate Matter (PM25)	≤ 20µg/m3	≤ 40 µg/m3 with no more than four exceedances per monitoring station annually

Source: Department of Environmental Affairs of South Africa 2018

At a cross-sectoral level, Cape Town's work to drive down air pollution includes reducing the city's reliance on coal as a source of energy and favouring renewable energy, supporting the installation of grid-tied small-scale embedded generation, particularly in the form of rooftop PV panels, making government buildings more green, working with communities to install thermal insulated ceilings and green infrastructure to reduce reliance on open fires and other energy and educating the next generation about climate change and air pollution. With respect to transport and mobility, the city encourages the public to make use of public transport, ride a bicycle, or car-pool to help relieve congestion to limit air pollution (according to the Five year integrated development plan 2017-2022, see City of Cape Town 2017).

In addition to these cross-cutting strategies and policies, the city implements air pollution reduction laws according to the national framework. That is, a plan and a by-law have been developed by the city's government to introduce standards for and monitoring/enforcement of air quality in the city's area.

The City's Air Quality Management Plan (AQMP, City of Cape Town 2005) was approved and implemented in 2005. This plan aims to ensure that clean air is achieved and maintained in the city over a period of 10-to-20 years. It includes a number of principles (amongst others: polluter pays, pollution prevention, public participation) and outlines a number of goals (amongst others: formulating an air quality management system, specifying air quality standards, prioritizing specific pollutants, improving air quality in informal areas, and enforcing current and future regulations).

This action plan has resulted in several area-specific action plans and the formulation of the Air Quality Management By-law in 2010, amended in 2016 (City of Cape Town 2016). The Air Quality Management By-law from 2016 was drafted and implemented with the aim to setting standards, enforcing these regulations by monitoring compliance as well as issuing penalties. More precisely, the Air Quality Management By-law sets local emission standards and smoke-control standards inside and outside dwellings. It encompasses other legal checks and balances, such as setting standards and specifications on fuel-burning equipment, standards and test procedures for vehicles, identifying and prioritizing substances emitted that present a threat to public and environmental health and setting standards for these, open-burning approvals, notices for contraventions.

As part of the standard setting, any installation (e.g. liquid fuel combustion) may be obliged to follow a dedicated air quality management plan. This is implemented as part of the national framework of atmospheric emission licensing.

Monitoring

Cape Town currently has a range of monitoring and evaluation systems and processes to detect and act on air pollution. First, this includes an air quality monitoring network which consists of 40 analysers at 14 ambient air quality monitoring stations located across the city. As part of the financial investment in monitoring equipment, the City's Scientific Services Department has also installed a camera monitoring system located on the Tygerberg Hills, an antenna to provide additional remote monitoring of air pollution episodes and industry.

On this basis, the City of Cape Town monitors air quality and provides an online air quality reading service, which provides real-time air quality information and readings and summaries for the previous day. Monthly reports and annual episode reports (where pollution levels exceed the accepted guidelines) are also available.

Moreover, the atmospheric emission licensing includes regular compliance monitoring by city officials (Air Quality Officer and Air Quality Management Unit, see below).

Finally, city inhabitants are welcomed to report air pollution to the city via an online platform or a telephone hotline. The local government called on the community to assist in fighting air pollution by reporting polluting industries, and reporting smoking diesel vehicles to the Air Quality Management Unit (Air Quality Officer, see below).

Air quality complaints in the City of Cape Town relate mainly to fumes and odour from farmland, tyre and waste burning. Between 2010 and 2015, the City of Cape Town inspected galvanizing facilities, illegal foundry operations, metal spray operations and hazardous waste incinerator operations and, where necessary, took appropriate action in an attempt to address and reduce complaints (Western Cape Government 2018).

The City of Cape Town also designed and Air Quality Booklet meant to help readers understand how they can help to keep pollution out of the air. It is both a source of information around the challenges presented by air pollution, and a practical guide on how they can be tackled together. One important reason for the City of Cape Town to work on a new public transport system with the Provincial Government of the Western Cape, is to reduce exhaust fumes of private motor vehicles.

Enforcement

The By-law has designated an enforcement power to the public, the "Air Quality Officer" and "Air Quality Management Unit". The By-law also stipulates a list of offences and penalties to enforce the standards and regulations.

In the following, we compare the measures' effectiveness by tracking the evolution of the air quality starting with 2005 (City of Cape Town 2018).

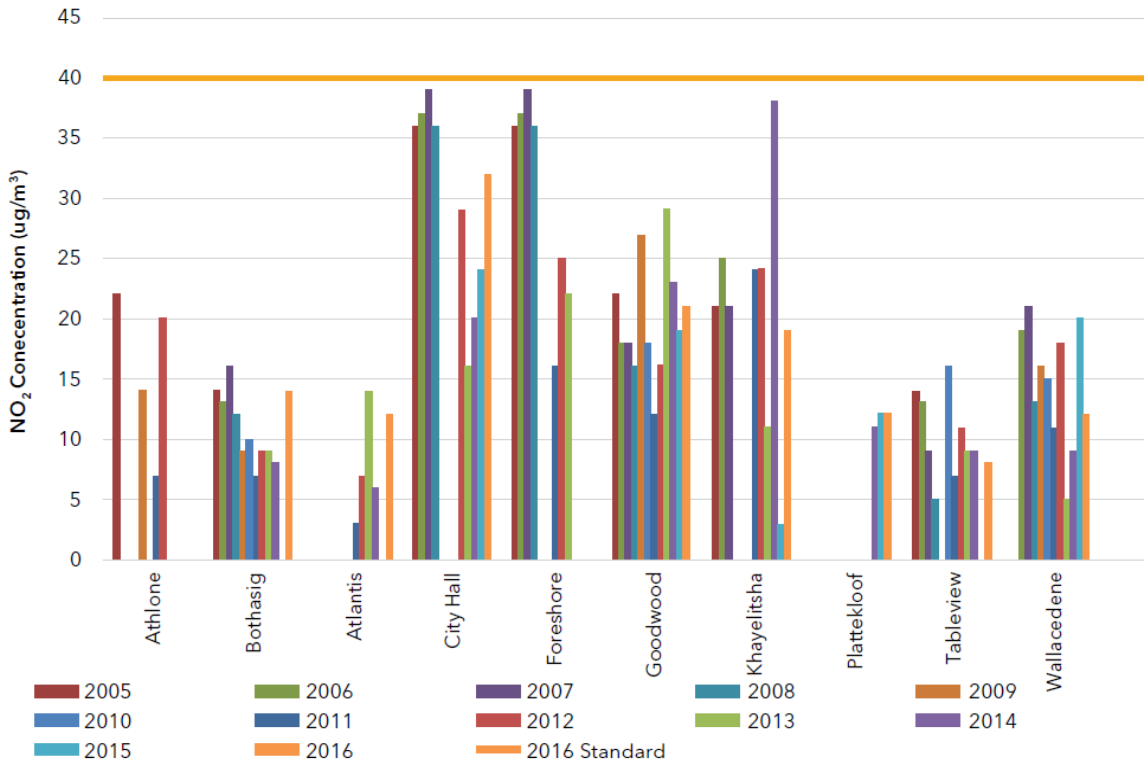
Air Quality Data

The „City of Cape Town State of the Environment Report 2018" provides data for air quality for the timeframe 2005-2016 and also encapsulates the previous reports issued by the city in 2009 and 2012. In this report, three main types of air pollutants are measured and used as indicators, namely NO_2, SO_2 and PM10.

NO_2 pollution has generally decreased over the years. Significantly, all measurement sites have had NO_2 levels below the South African Standards over the past 12 years. The city centre

experiences the highest levels of NO_2 pollution, but this is largely due to vehicle emissions from the large number of cars and taxis entering.

Figure 38: Annual NO2 averages, 2005-2016

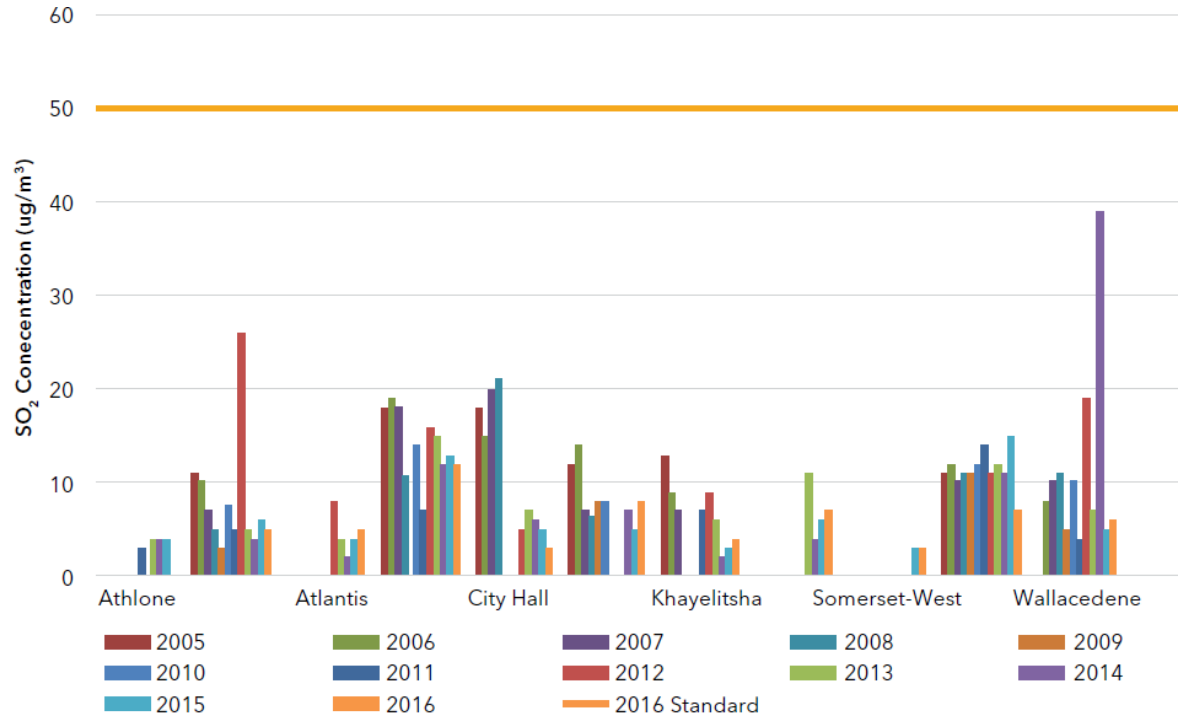


Source: City of Cape Town 2018

SO_2 levels in the city are generally low and considerably below the legislated South African air quality standards. Most ambient monitoring sites have maintained similar trends throughout the past 12 years, with discrepancies occurring every few years. The spikes can be attributed to industrial activities or to vehicle emissions in close proximity to the station of measurement. Some monitoring stations are located on premises where vehicles are subjected to start-up in the morning and left to idle for significant periods, causing data spikes. Additionally, instrument malfunction could have also played a role in the recording of higher SO_2 levels.

Generally, SO_2 levels have experienced a downward trend over the past 12 years. This is a result of the introduction of mandatory lower Sulphur content in diesel fuels, which decreased from 5000ppm to 500ppm with 50ppm being readily available for consumers to use. It is important to note that even if industry is not situated directly next to the ambient monitoring site, the transboundary nature of air pollution can impact a large area.

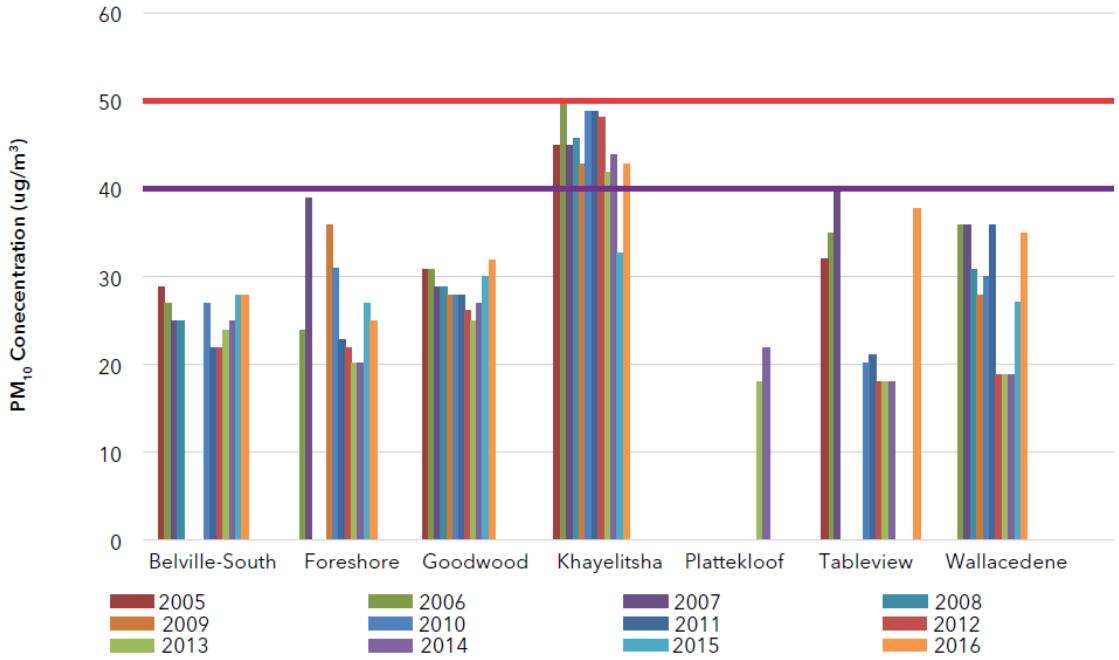
Figure 39: Annual SO_2 averages, 2005-2016



Source: City of Cape Town 2018

PM10 levels in Cape Town have generally been lower than that required by both the 2009 – 2014 interim standard, and the 2015 standard. However, PM10 pollution has been observed to have considerably increased at most sites in recent years. The exceedances are attributed to informal burning for cooking and heating in close proximity to some Air Quality Monitoring Stations and the surrounding area. In 2015, some monitors had the lowest recording of PM10 in the past 12 years, meeting both the 2009 – 2014 interim standard and the 2015 standard. Other monitoring sites have recorded a considerable decrease in PM10 since 2009, with increases only experienced again in 2015. While others experienced significant increases in PM10 pollution in 2016. These trends could be attributed to a number of factors which could include the proximity of the monitoring site to a possible infrastructural development, or the season that the development underwent construction. The number of exceedances of the PM10 daily average threshold in the years 2009 to 2016 above four has been in the two townships Khayelitsha and Wallacedene mainly due to paraffin burnings.

Figure 40: Annual PM10 averages, 2005-2016



Source: City of Cape Town 2018

In summary, over the past 12 years, air quality in most areas has met the National Ambient Air Quality Standards apart from minor exceedances due to extenuating circumstances, such as sporadic localized bush fires and traffic congestion due to lengthy road upgrades.

21.5 Spotlight: Water management

In the current severe drought, water supply is stretched to the limits, highlighting the city's position in a water-scarce region. Changing weather patterns due to climate change have contributed to the drought, with increasingly long, hot and dry summer months.

The City of Cape Town is part of the Western Cape Water Supply System, which gets its water from a system of dams that supply agriculture and other urban areas. The current system is almost entirely dependent on rainfall. The National Department of Water and Sanitation (DWS) manages the three largest dams in the system and is responsible for planning and implementing water resource schemes to meet water demand for cities, industries, mining and agriculture.

As previously mentioned, Cape Town receives 98% of its potable municipal water from a large and sophisticated system of mountain-fed dams extending into the regional hinterland. While dam-building projects have met the city's needs for a century, Cape Town is now turning to the area's significant underground aquifers. But as local municipalities are moving ahead with drilling, some stakeholders from civil society and academia are concerned that the city's current plans put both the unique biodiversity of the region and the aquifer's long-term sustainability at risk.

Standards, guidelines and policies

The city's supply of water is a collaboration between the City's Water and Sanitation Department and the DWS. In 2007, the City implemented a Water Conservation and Water Demand Management Strategy (WCWDM programme, City of Cape Town 2007). The strategy aims to minimize water losses and promote efficient water use by focusing on both technical and behavioural aspects of saving water.

The WCWDM initiatives have generally been implemented earlier in Cape Town than in other South African cities, driven by an awareness of water scarcity in the region. Many projects implemented in Cape Town were ground-breaking at the time and have since been mainstreamed and incorporated into national guidelines and policies (Sinclair-Smith & Winter 2018). In 2015, the WCWDM programme received the C40 Cities Award for best climate change adaptation implementation project at the Paris COP21 climate negotiations (C40 Cities, 2015). It includes the following features (ibid.):

a) Managing water pressure: extension of the lifespans of water mains and plumbing fittings, and the reduction in pipe bursts.

b) Minimising water leaks from the municipal network: ongoing maintenance.

c) Pipe replacement programme: The City of Cape Town replaces approximately 60 km of old pipelines every year.

d) Substituting potable water with non-potable sources: Treated effluent or treated sewage water is supplied to consumers for industrial purposes, agriculture sports clubs and schools.

e) Improving water metering: Accurate metering and billing to ensure responsible and efficient use.

f) Water tariffs: The tariffs are rising, but have social components. The first 6000 litres of water per month is provided free of charge to all households in accordance with national policy on basic human needs and access to services.

g) Information and research: An important component of the WCWDM programme is permanent measurement and monitoring of water losses. There are indicators monitoring the effectiveness of the WCWDM programme and scrutiny from political leadership, the public and national departments.

h) By-laws and enforcement: The City has progressively tightened water regulations. The 2011 amended Water By-Law introduced a number of important water saving measures, including permanent restrictions on garden watering times, which were previously only applicable during water restrictions.

i) Addressing water leaks in low-income households: The City has adopted an integrated approach for managing debt and water leakage in households.

j) Education and awareness: The „Keep saving water“ program is marketed through a variety of media including press statements, radio, newspaper advertisements, city website, billboards and signage on council vehicles.

k) Innovative approaches in low-income communities: Free of charge plumbing repairs and other initiatives.

The City’s 2009-2014 Integrated Metropolitan Environmental Policy (IMEP) Environmental Agenda envisioned a target of providing 180 litres of water daily per capita. This was based on a history of high-water demand. The aim was to reduce the amount of water used in wealthy households and to ensure that poorer households are given increased access to water.

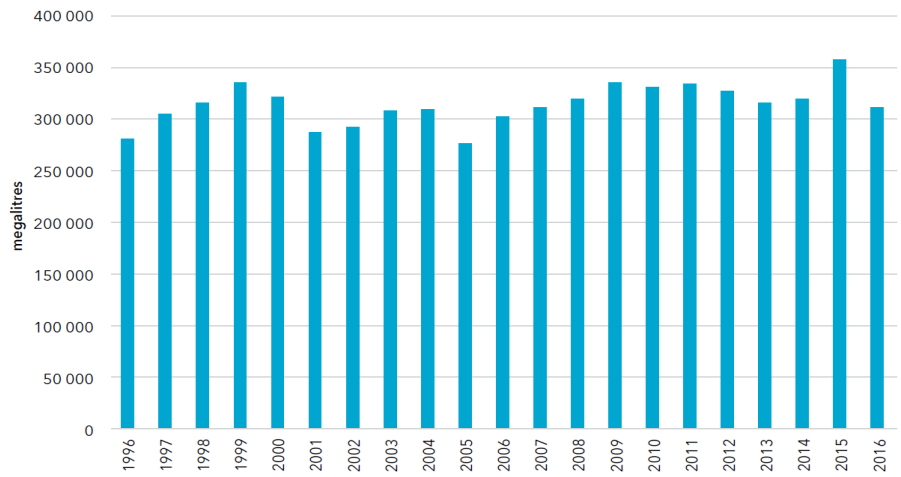
In the current drought conditions, the daily water consumption target per person has been drastically reduced. The City urged residential water users to use a maximum of 50 litres of water per person daily, with an overall total water demand target of less than 450 megalitres per day.

A special measure took by the South African government was the „Day Zero "campaign. The government faced the prospect of its largest city running out of water – a moment when dam levels would be so low that they would turn off the taps in Cape Town and send people to communal water collection points. After years of trying to convince residents to conserve, the aggressive campaign jolted people into action. Water use was (and still is) restricted to 50 liters per person per day. Households that exceed the limit face fines, or having a meter installed in their home that shuts off their water once they go over. Therefore, Capetonians started showering standing over buckets to catch and re-use that water, recycling washing machine water, and limiting flushes to once a day.

Results

Prior to 2001, water demand was growing at an unsustainable rate. Average annual growth before 2001 was at 4% (City of Cape Town, 2007). Since, Cape Town's water use has remained relatively stable over the last 20 years despite a rapidly increasing population. In 2015, the city recorded its highest ever water usage with 357 865 Mln treated and used, a drastic increase, which probably is a result of prolonged warmer and drier weather. 2016 had the lowest water usage in the previous 10 years.

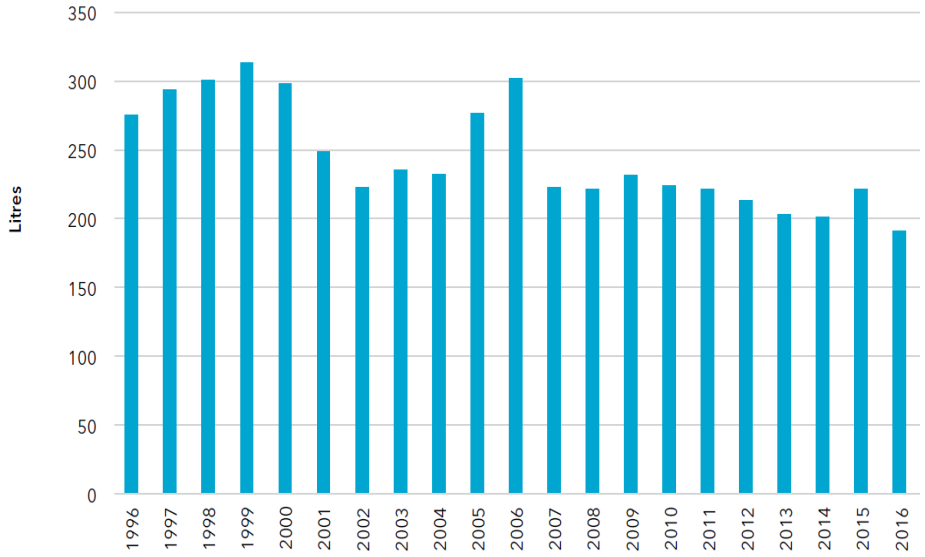
Figure 41: Annual water treated and provided by City of Cape Town, 1996-2016



Source: City of Cape Town 2018

In 2016, each resident accounted for an estimated average of 191 litres of water per day. This was a decrease of 31.29 litres per resident per day from the previous year, in line with the trend of decreasing per capita use since 2009 but still higher than the 2014 Environmental Agenda target of 180 litres per capita daily. In July 2017, daily per capita water usage was 140 litres, which achieves the target. However, this does not reflect inequalities in access to water and the varied amount of water used per person across Cape Town, as some residents only have access to shared water points.

Figure 42: Daily water use per capita in City of Cape Town, 1996-2016

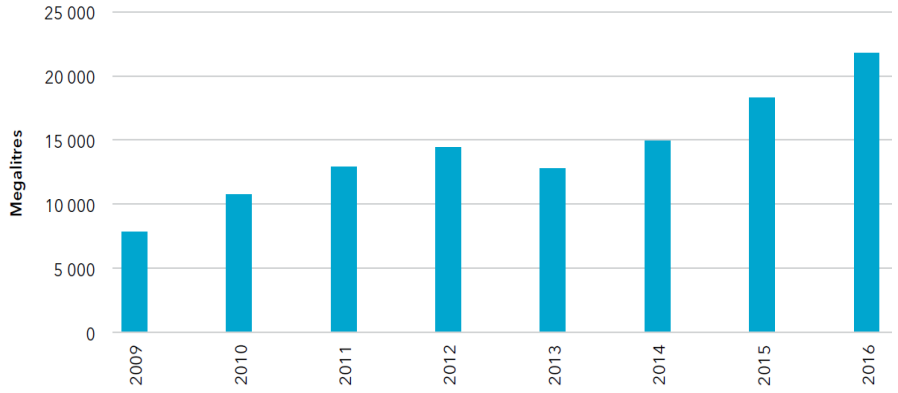


Source: City of Cape Town 2018

The stability in water demand and the decline in water usage in 2016 follows the implementation of water restrictions and various the city initiatives under the WCWDM programme. There is also increased consumer awareness of water saving, with improved maintenance of household plumbing by fixing leaks and installing more water-wise toilets, taps and shower heads. Water restrictions implemented during 2016 and 2017 have also contributed to reduced water usage.

The City has increased its efforts in reusing water, in accordance with water demand and conservation initiatives, as illustrated in Figure 43. As mentioned, currently the City does not recycle water for drinking use but treats wastewater for reuse in industry and for watering golf courses and sports grounds.

Figure 43: Water reused in City of Cape Town, 2009-2016



Source: City of Cape Town 2018

Conclusions

Overall water usage has decreased. In 2016 water usage was lower than in previous years after a drastic increase in 2015. The Environmental Agenda 2014 target is to reduce per capita usage to 180 litres per day. During the current drought conditions, usage should be in line with applicable

water restrictions. These targets have been met. But there is still a need to reduce water consumption drastically under drought conditions. Global warming and climate change lead to more periods of drought and increase the need for more stringent measures regarding water consumption in the context of climate change adaption.

According to Sinclair-Smith & Winter (2018), the Cape Town's WCWDM programme has played an important role in stabilising water demand growth despite the rapid urban growth. This had reduced the city's vulnerability to climate change-related risks to water security. It had also played an important role in reducing environmental impacts and improving financial sustainability. Sinclair-Smith & Winter attribute the success of the different initiatives to their early introduction and the implementation of a comprehensive policy in 2007, which was given sufficient institutional support and which was given a dedicated budget, staff and management structure.

22 Case Study: Jakarta, Indonesia

Jakarta (officially the Special Capital Region of Jakarta) is Indonesia´s capital, located at the coast of the north-western island Java. With a metropolitan population of more than 10,1 million inhabitants living in the five administrative municipalities, including Selatan (South Jakarta), Timur (East Jakarta), Pusat (Central Jakarta), Barat (West Jakarta), and Utara (North Jakarta), in 2015, predicted to reach 14 million inhabitants in 2035, Jakarta is one of the fastest growing mega-cities worldwide and represents Indonesia´s economic, political and cultural centre (United Nations 2018). The total land area of Special Capital Region of Jakarta covers around 662km^2, translating into a population density of around 15.6 thousand individuals per square kilometre (World's Capital Cities n.d.).

22.1 Urban environmental protection challenges

Jakarta faces a number of environmental challenges, including air and water pollution, waste generation and management, the loss of biodiversity, soil degradation and soil subsidence due to climate change and its effects.

Air pollution

With a yearly average PM2.5 of 45.3 µg/m^3, Jakarta has been one of the two most polluted cities in South East Asia in 2018. High urban pollution levels are correlated with a rapidly rising population and in that context also with more transportation, large scale industrial activities and larger numbers of small vehicles such as motorbikes (AirVisual 2018). The Indonesian Statistical Agency reported in 2017 that there were around 18.7 million vehicles, including motorcycles, passenger cars, cargo cars, buses and trucks on the roads in Jakarta in 2016 (Kusumaningtyas 2017).

According to some sources, Jakarta's inhabitants have access to clean air only 27 days a year (Conservation International 2017). Moreover, a 2002 study of the Asian Development Bank estimated economic costs due to air pollution (in particular PM10 pollution) in Jakarta to account for IDR 1.7 trillion in 1998, predicted to increase to IDR 4.2 trillion in 2015 without any further regulations with respect to air pollution (CAI-Asia 2010).

Air pollution in Jakarta has multiple causes, including the emissions from motorized transport due to inefficient engines, congestion in urban areas and poor public transport systems, as well as open waste dumps, the reduction of green spaces and urban land cover. Urban transportation is identified by the Environmental Ministry as the main cause for air pollution contributing up to 70 percent of fine particles and 75 percent of total greenhouse gas emissions (Indonesia Habitat National Team 2016). In 2010, Jakarta had a PM2.5 level, lying far above the WHO guideline of 10 µg/m^3. Jakarta has conducted several emission inventory studies, to identify the primary sources of emissions and air pollution (e.g. Lestari et al. 2020). The conclusion of all studies identified transportation to be the main source of hydrocarbon, carbon monoxide, nitrogen oxide, and particulate matter (PM10), industry to be the primary source of sulphur dioxide. Air pollution leads to various negative consequences for Jakarta, including for instance acidic rain. In a 2000-2016 study, the Indonesian Ministry of Environment and Forestry states that acidic levels of pH in the rainwater in Jakarta reach a level of 5.6-4.31, whereas the standard level for rain water lies at a value of 5.6 (Widya Yudha 2017).

Climate Change and its effects

Indonesia is vulnerable to climate change and its effects not just because of the loss of its biodiversity, but in particular because of the rise in extreme rain falls, the increase in urban

flooding, and the rise in the sea level, and their combined effects on coastal areas, including issues such as food security, public health and water availability, affecting in particular the urban poor (Worldbank 2010). Jakarta's districts are affected disproportionally by the impacts of climate change. For example, Jawa Timur, Jawa Tengah and Jawa Barat are estimated to bear the projected costs emerging from the consequences of the dengue fever and gradual sea level rise at a proportion of 19 percent, 15 percent and 9.5 percent of total costs, respectively (Hecht 2016).

Water pollution and access to water

Jakarta's drinking water stems mainly from surface waters, 80 percent of it coming from the Citarum River, which is located in the eastern part of the city (Hartono 2018). Jakarta´s surface waters, consisting of 13 rivers, is heavily polluted, causing water recycling and treatment costs to increase. Industrial sewage, contaminated run-offs from agricultural land, an inadequate sanitation system, increasing urbanisation density, private waste combustion and the reduction in water catchment areas have led to shallow groundwater pollution, in particular in the Java island, where Jakarta is located, as well as the Kalimantan island (Indonesia Habitat National Team 2016).

Land Sealing and Soil degradation

Urban settlements in Indonesia are massively affected by land sealing, reducing not only public green spaces (e.g. green space in Indonesian cities was reduced from 35% in the 1970s to less than 10% in 2006) and therefore the quality of living in urban areas, but also increasing risks of natural disasters such as flooding and the impacts of extreme weather conditions such as extreme rain falls (Nasution & Zahrah 2014). Two decades ago, for instance, the highest rainfall intensity in Jakarta accounted for 100 mm/day, while in 2016, it reached a level of 350mm/day (Indonesia Habitat National Team 2016). At the same time, Jakarta´s water drainage system is not yet updated to the new rainfall conditions, causing a low resilience to extreme weather events. Moreover, 13 rivers intersect the city, which faces annual flooding and inundations, such as in 1996, 2002, 2007 and 2013, when up to 70 percent of the city were inundated (UNU-IAS 2015).

Soil subsidence

A central issue in the context of climate change in Indonesia is soil erosion and accession in coastal areas. Jakarta as a coastal city is directly affected by the problem. Beside climate change, ground water extraction and urban development, including high-rise building and tunnelling for example, represent major causes for soil subsidence in the city, leading to a yearly subsidence rate of around 20mm (Hendarto and Standing, 2019). Furthermore, land subsidence is a direct cause of urban flooding due to improper discharge of inundation water in urban areas; in a damage cost assessment, around 79 percent of urban flooding is associated to land subsidence (Ministry of National Development 2012). In particular the urban poor represent the most vulnerable group, suffering under the impact of tidal flooding and land subsidence (Indonesia Habitat National Team 2016).

Waste generation and management

It is estimated that only around 70 percent of total urban population in Indonesia (around 135 million individuals) have access to waste collection services and "55 percent of urban solid waste is handled at a transfer station or processing facility" (Worldbank 2017). Without access to waste collection services, air pollution is significantly increased by open (informal) burning and disposal of waste on dump sites, underground or into rivers, leading to public health damages, in particular to poor and vulnerable groups. In Jakarta, 5,802 tons of garbage are

produced per day, but only 5,228 tons are collected, indicating an inefficient waste management system (Andriani 2015).

Loss of biodiversity

The loss of biodiversity is considered a national problem in Indonesia rather than just a problem arising in urban areas such as Jakarta. The destruction of non-urban rainforests and coastal waters as well as natural riverbanks bring Indonesia´s biodiversity, including 10 percent of all known plant species, 12 percent of mammal species and 17 percent of the world´s bird species, at risk (RAN n.d.). Jakarta´s loss in biodiversity as such is affected in particular through the reduction in public green spaces. The increasing urbanisation density, including the construction of new residential and commercial buildings, massively reduced public green spaces during the past two decades in Jakarta and therefore also the biodiversity in the city. Whereas in 2007, around 33,467 hectares (29 percent) were covered by urban green areas, in 2013, Jakarta had only around 10,008 hectares (9 percent) of green areas (UNU-IAS 2015).

22.2 Cross-sectoral policies and measures to protect the urban environment

Jakarta has progressively developed various sectoral and cross-sectoral policies with respect to urban environmental protection. These include instruments for emission reduction, resource efficiency, air quality improvement, waste management and sustainable urban planning (e.g. alternative mobility options such as a rapid bus transit system). Efforts to protect the urban environment have been developed since 1965 in the form of Master-Plans, which are revised every five years, or most recently, in the form of the Green Building Code, which is a legally binding instrument covering the fields of energy-, water-, and material effiency as well as waste management and urban green zoning. These as well as other local cross-sectoral policies are summarized in Table 30.

Table 30: Cross-sectoral policies in Jakarta

Cross-Sectoral Policies	Initiation and Time Span	Content
Green Building Code	Since Governor's Regulation No. 38/2012	Energy efficiency Water efficiency Material efficiency Waste management Management and creation of urban green zones
Jakarta Master-Plans	since 1965; currently: 2008-2027 (Jabotabek Spatial Plan-through Presidential Decree No. 54/2008)	Current plan: revision every 5 years, economic and environmental preservation, water and soil protection, preservation ground and surface water, overcome flood disasters, sustainable economic development, expansion and development of urban transit system
Governor Regulation 131/2012	Initiation 2012, reviewed 2015, target year is 2030.	Local Action Plan for GHG Emission Reduction. Commitment to reduce energy,

Cross-Sectoral Policies	Initiation and Time Span	Content
		water, and GHG emissions by 30% in 2030. Sectoral coverage: energy (transport, commercial, households, industry, others), solid and liquid waste, and LULUCF

Source: Own compilation based on MLIT (n.d), Wuppertal Institute

Jakarta´s policies and measures are embedded in the framework of national policies, meaning that national policies prevail in a legal sense, whereas local policies have to be aligned. Various fields, that are analysed in more depth in the following, also highlight the need to tackle environmental problems by applying a bottom-up approach, such as for instance in the field of solid waste management where the Law No. 18/2008 on Solid Waste Management emphasizes the necessity that local agencies and municipalities implement solid waste management systems.

22.3 Overview of activities in different fields

Air pollution

Air pollution in Jakarta is tackled by a number of different bylaws.

Between 1998 and 2000, the Ministry of Environment established the Air Quality Monitoring Network System (AQMS), consisting of 33 air quality monitoring stations located in various cities, including Jakarta. Data is collected and sent to the Regional Air Quality Monitoring Center (RAQMC), verifying and reporting to the Ministry of environment. Data from the AQMS is then converted into the Pollution Standard Index, to which some cities, including Jakarta, provide access for the population. However, only three out of five monitoring stations in Jakarta were operating in Jakarta in 2010 (CAI-Asia 2010).

Government Regulation No. 41/1999, covering Air Pollution Control and emission standards, enables provincial governments "to set regional vehicle emission standards, industrial emission standards, and ambient air quality standards that are more stringent than or at least equivalent to the national standards. However, city governments have no authority to issue either emission standards or ambient air quality standards" (CAI-Asia 2010). Nevertheless, city governments are allowed to issue bylaws. In that context, the province Jakarta has implemented various regulations.

One of the most relevant regulations is the Regional Regulation of the Province of Jakarta Capital Sepcial Region No. 2/2005, tackling air pollution in the area. The city has further issued a regulation on the Gas Fuel Usage for Public Transport and Government Operational Vehicles (Governor Regulation No. 141/2007), Vehicle Emission Test and Vehicle Maintenance (Governor Regulation No. 92/2007) as well as Non-Smoking Areas (Governor Regulation No. 75/2005 and No. 88/2010) (CAI-Asia 2010). Furthermore, it issued Bylaw No. 12/2003 concerning Traffic and Transportation as well as the Governor Decree No. 84/2004, presenting a macro transportation plan for the time span 2007-2020, comprising the development of a bus rapid transit, a rail-based transportation infrastructure, including a mass rapid transit, light rail train and river transportation as well as transport demand management and parking restrictions. Also in the area of transportation, the city has issued local act No. 22/2009 on Traffic and Road Transportation, which represents the legal basis for the management of land transportation,

including the control of vehicle emissions. In that context, local act No. 4/2014 has been issued, regulating and improving the traffic and transport management in the city, including the opportunity to use environmentally friendly fuels. In addition, in 2010, the Minister of Energy and Mineral Resources has issued Regulation No 19/2010 on the utilization of CNG for transportation – tackling the problem of limited CNG supply for transportation – particularly in Jakarta. In 2001, the city has issued Governor of DKI Jakarta Decree No. 1041, setting stricter standards for in-use vehicles than those that are set for the national level, supporting the development of the inspection and maintenance system for private passenger vehicles in Jakarta (Urbanemissions 2017).

However, although the basic legal framework to tackle air pollution is already in place, there is a lack of enforcement strategies in Jakarta, which, in 2006, has been ranked as the third most polluted mega-city worldwide by the United Nations Environmental Program. The Urban Air Quality Improvement Sector Development Program (UAQ-I SDP) has been, therefore, introduced in order to support the Indonesian Government to improve enforcement of laws and regulations. Jakarta and Yogyakarta were pre-selected as focus cities due to their high pollution levels, and various replication cities were included into the program (UAQ-i Final Report 2006).

Climate change and its effects

Climate mitigation and adaption strategies represent an integrated concept in which Jakarta´s climate strategy can be embedded.

Jakarta´s climate strategy is embedded on the one hand in the National Action Plan for Greenhouse Gas Emission Reduction (RAN-GRK), forming Indonesia´s cross-sectorial framework to mitigate the effects of climate change. The Action Plan comprises seven key mitigation sectors, including forestry, energy efficiency, renewable energy, solid and liquid waste and transport and serves as a guideline for national, regional as well as local governments (IEA 2015).

On the other hand, Jakarta´s climate strategy is embedded in the 2007 National Action Plan (NAP) on Climate Change, forming Indonesia´s cross-sectorial framework to mitigate the effects of climate change. The Action Plan serves as a guidance for various agencies to mitigate climate change and highlights the need for institutional coordination (CAI-Asia 2010).

Moreover, Jakarta has undertaken various actions in order to tackle climate change. In 2012, it has issued Regulation 131/2012, initiating a local action plan for GHG emission reduction. Thereby the city committed to reduce energy, water and GHG emissions by 30 percent by 2030. In 2007, Jakarta joined the C40 Cities Climate Leadership Group, which is an association of cities that commits itself to combat climate change. In 2009, it declared to lower GHG emissions by 30% in 2030, by implementing the Spatial Planning (RTRW) as well as the Regional Action Plan for GHG Emissions Decrease. In 2012, Governor Regulation No. 38/2012 set up the Green Building Code (Governor Regulation No. 38 2012). It “regulates the implementation of the concept of energy efficiency and environmentally buildings. Green building means a building that is responsible against environment and resource efficiency since the planning, construction, utilization, maintenance, until deconstruction” (Article 1 No. 11 of Green Building Code) (Amanda 2012). As such, the Green Building Code is a cross-sectorial plan, since it requires energy efficiency, water efficiency, indoor air quality, and efficient land and waste management for new buildings. Not issuing a Building Construction License or a Certificate of Feasible Function is sanctioned.

Water pollution and access to water

In 2012, Jakarta´s municipality has issued the Green Building code, comprising amongst others water efficiency requirements. It addresses issues such as water scarcity, sewage treatment,

water consumption, and water management (Government of the Province of the Jakarta Capital Special Territory 2012a). The Code is mandatory and, hence, sets ambitious goals for the city (Government of the Province of the Jakarta Capital Special Territory 2012b). Furthermore, the city has issued the Regulation of the Governor of Jakarta No. 25/2011, setting up the Environmental and Ground Water Management Unit, which has the duty to organize management and control activities with regard to groundwater and waste in the city.

Waste generation and management

Solid and hazardous waste management regulations are enacted in both national and local legislation whereas national regulations have juristic authority. Therefore, local policies have to be aligned with national legislation.

The following presents the most important solid waste management policies, implemented at a national, regional and local level. National and regional policies are also considered here, since they are relevant also for local policies which have to be aligned. Law No. 18/2008 as well as Provincial Regulation No. 3/2013 and Governor Instruction No. 157/2016 will be discussed in more depth.

Table 31: Solid Waste Management in Indonesia and Jakarta

Level	Legislative Instruments
Law	Law No. 18/2008 on Solid Waste Management
Government Regulations	Governmental Regulation No. 81/2012 on Management of Households and Households-like Waste Governmental Regulation No. 82/2001 on Water Quality Management and Water Pollution Control
Presidential Regulations	Presidential Regulation No. 18/2016 on Acceleration of Development of Waste-to-Energy Plant in Province of DKI Jakarta, Cities of Tangerang, Bandung, Semarang, Surakarta, Surabaya and Makassar (REVOKED) Presidential Regulation No. 38/2015 concerning the Cooperation between Government and Enterprises on Infrastructure Provision.
Ministerial Regulations	Regulation No. 50/2017 on Utilization of Renewable Energy Resources for Electricity Supply, Regulation No. P.70/Menlhk/Setjen/Kum.1/8/2016 on Emission Quality Standard from Thermal Waste Treatment Activities, Regulation No. P.59/Menlhk/Setjen/Kum.1/7/2016 on Leachate Quality Standard from Landfill Processing Activities, Regulation No. 44/2015 on Electricity Purchased by PLN Sourced from City Waste-to-Energy Plant, Regulation No. 3/2013 on Implementation of Solid Waste Infrastructure and Facilities in Handling Household and Household-like Solid Waste, Regulation No. 33/2010 on Solid Waste Management Guideline
Provincial and Local Regulations	Provincial Regulation No. 3/2013 on Solid Waste Management, Provincial Regulation No. 6/2012 on RPJMD 2005 – 2025, Provincial Regulation No. 1/2012 on Spatial Plan 2030, Governor Instruction No. 157/2016 on Supervision and Development of Waste Bank

Source: EP&T and DIM 2017

According to the Solid Waste Management Act No. 18/2008, waste management issues shall be implemented on a local level by municipalities. “Each regional authority has the right to define

its policies and strategy for the implementation of solid waste management systems from waste collection and to final disposal, so long as they respect the province´s policies and strategy" (EP&T and DIM). In Jakarta, the Province Environmental Department is in charge of environmental protection and waste management, collecting reports from each administrative area in Jakarta (South, West, Central, North and East Jakarta) about their solid waste management activities and coordinating and supervising the implementation of waste management regulations. To this end, each administrative area is equipped with local environmental agencies, representing the Province Environmental Department on small scale local level.

Provincial Regulation No. 3/2013 on Solid Waste Management requires the establishment of a Master Plan and legislative framework for waste management in Jakarta. The waste prevention, recycling, utilization, sorting, collection, transport, processing and integrated treatment in Intermediate Treatment Facilities represent priorities in the Master Plan due to the current problem of overfilled landfills (EP&T and DIM 2017).

The Governor Instruction No. 157/2016 on Supervision and Development of Waste Bank, guides, assists and coordinates the development programme and establishment of Waste Banks, and supports and mobilises community participation. This includes activities such as informing about the need to handle waste at the source level, undertaking waste management and sorting, waste utilisation and recycling and controlling disease and hygiene (EP&T and DIM 2017).

Loss of biodiversity

Similar to waste management strategies, policies that tackle the loss of biodiversity in Jakarta have to be in line with national policies. On a national level, the Indonesia government formulated the Biodiversity Strategy and Action Plan for 2015 to 2020 (IBSAP), which emphasizes the need for a bottom-up approach with regards to biodiversity maintenance (Nalang, n.d.).

22.4 Spotlight: Climate Change and its effects

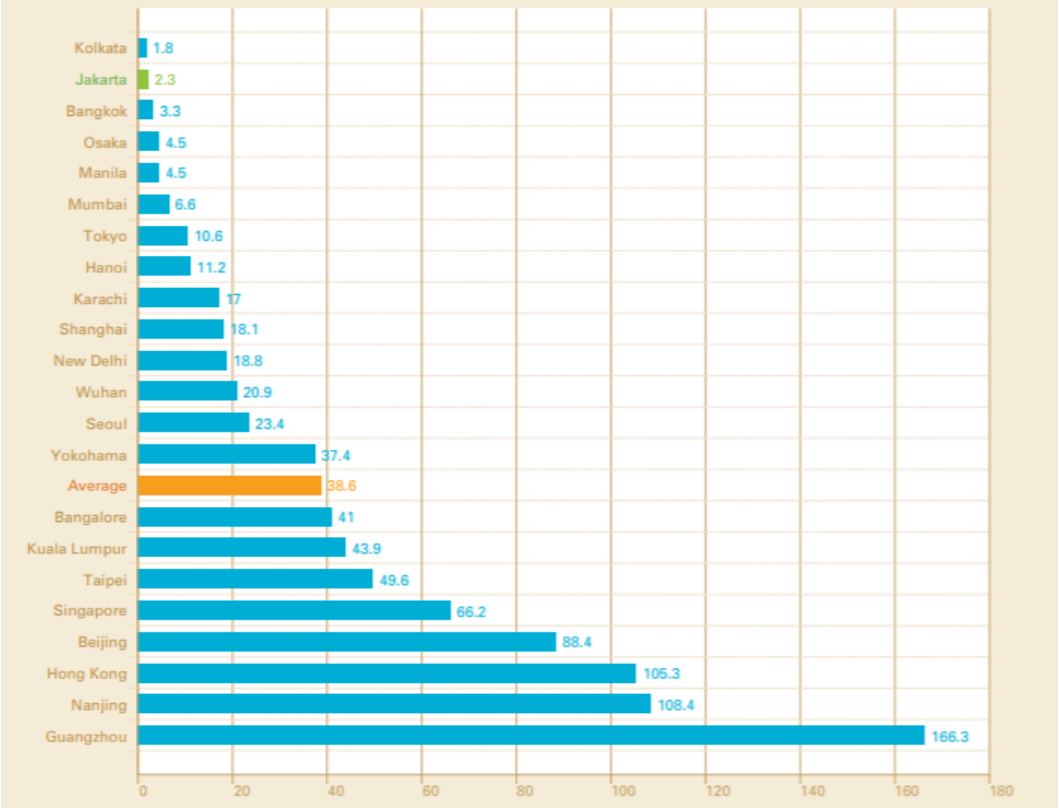
On a national level, the Indonesian government has set a 26 per cent greenhouse gas reduction target for 2020 (41 per cent with sufficient international support). On a provincial level, Jakarta has set a reduction target of 30 percent by 2030 (Regulation 131/2012). Moreover, climate change adaption measures include structural and technical measures, such as drainage improvement or absorption walls to handle flooding, but also non-structural measures, such as programs to raise awareness, law enforcement and early warning and emergency systems, such as the Jakarta Flood Management, the Jakarta Emergency Dredging Initiative (JEDI) or the Jakarta Coastal Defence Strategy (C40 Jakarta). Another initiative developed by the Jakarta government is the Green Building Code.

Covering a cross-sectoral field of activities, the Green Building Code is a relevant mandatory legal instrument for urban environmental protection in Jakarta, promulgated through the Governor's Regulation No. 38/2012. It is based on the vision that 100 per cent of all new buildings and 60 per cent of all existing buildings meet the Green Building Code by 2030. The Green Building Code plans a 1.37 million metric tons of CO2 emissions reduction by 2030 (Government of the Province of Jakarta Capital Special Territory 2012b). This carbon emission cut is based on the idea of regulating areas such as urban energy, (including for instance air conditioning and ventilation, as well as the lighting system) water and material efficiency as well as landscape management. Further, it applies in mandatory form to all new and existing buildings in the city. The following briefly addresses each of these fields:

Landscape Management

The green area per capita available for Jakarta´s residents adds up to only around 2.3m², which is one of the lowest compared to other larger Southeast Asian cities (see also Figure 44). Only Kolkata with a per capita green area of 1.8m² lies behind Jakarta.

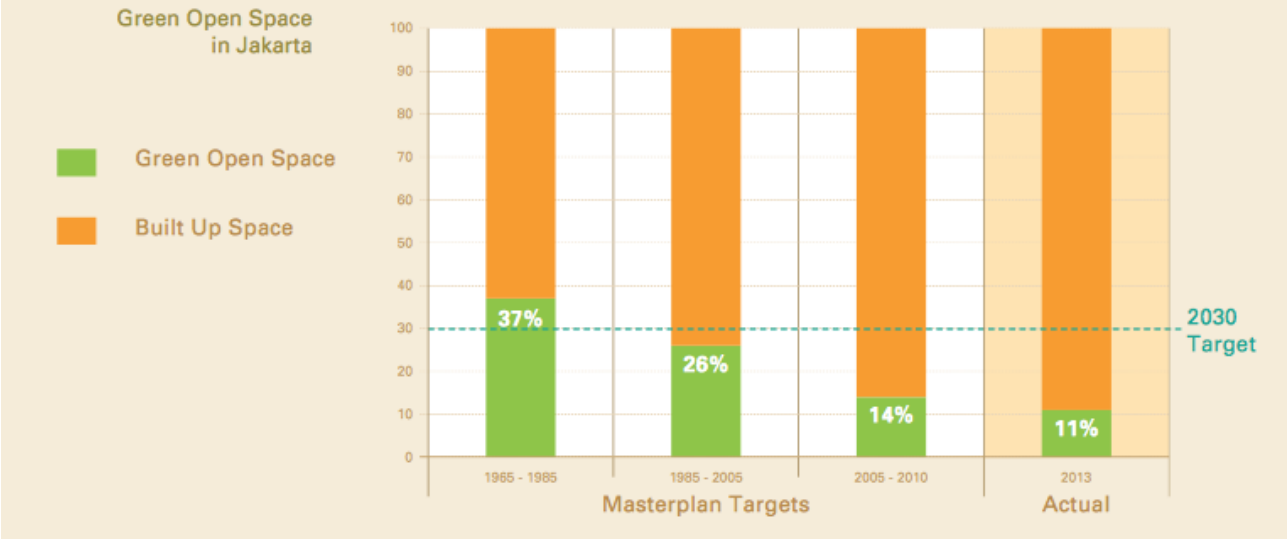
Figure 44: Comparison of green open space (m²/person) in Asian cities



Source: Government of the Province of Jakarta Capital Special Territory 2012b

Moreover, public green space targets were reduced in the government's masterplans from 37 per cent from 1965-1985 to 14 per cent in the period 2005-2010. To counteract this development, Jakarta plans in its Green Building Code public green zones to cover 30 per cent of the urban area by 2030 by setting a minimum of green open areas for new construction projects and by creating parks and green belts, and supporting privately owned green open spaces (see also Figure 45) (Government of the Province of Jakarta Capital Special Territory 2012b).

Figure 45: Green Open Space in Jakarta



Source: Government of the Province of Jakarta Capital Special Territory 2012b

Water Efficiency

54 per cent of water consumption comes from Jakarta's centralized piped water network, while 46 per cent comes from ground water supplies. Around 70 per cent of households in Jakarta depend in fact on the extraction of ground water. Moreover, around 50 per cent of water supply gets lost due to leakages. Another problem arises from the increasing rate of land subsidence. Around 32.5 per cent of the urban area of Jakarta is estimated to lie under the average sea level by 2050. Therefore, an "integrated approach of appropriate utilization & management of surface water, ground water / rain, waste treated water" is needed (Government of the Province of Jakarta Capital Special Territory 2012b).

The Green Building Code addresses these aspects by reducing water demand for ground water through the support of fixtures, rainwater harvesting and water recycling, reducing water runoffs through the collection of rainwater and absorption wells (Government of the Province of Jakarta Capital Special Territory 2012b).

Air Conditioning and ventilation systems

Air conditioning consumes most building energy and constitutes, therefore, an important factor that is tackled by the Jakarta municipality. According to some estimations, a reduction of around 1.37 million metric tons of CO_2 emissions is possible by 2030 through the implementation of the efficiency improvements into new buildings in Jakarta.

With regards to ventilation systems, the Jakarta Special Capital Region Province Governor Regulation No. 54/2008 on Indoor Air Quality Standard sets quality standards for various building types (e.g. office, hotel, shopping mall etc.). In addition, the Green Building Code mandates the introduction of automatic control of ventilation in public spaces and enclosed parking spaces due to the accumulation of CO2 in case of inefficient ventilation (Government of the Province of Jakarta Capital Special Territory 2012b).

Building Envelope

To support the reduction of energy consumption, the components of building envelope, comprising elements such as walls and fenestration systems, are relevant. A combination of building design strategies such as high-performance glasses, external shadings and a reduction

in window area could potentially lead to a 25 per cent energy saving in buildings in Jakarta (Government of the Province of Jakarta Capital Special Territory 2012b).

Other areas that are also included in the Green Building Code comprise lighting systems, and electricity and vertical transportation.

Outcomes

According to the Jakarta government, the Green Building Code "has resulted in 260 buildings with more than 15 million square meters" with a total energy saving of 853,914 MWh per year, 68,313,105 US dollar savings per year and a CO_2 reduction of 605,425 metric tons per year (Government of the Province of Jakarta Capital Special Territory 2012b). Furthermore, according to a report about GHG emission reductions in Jakarta (2019), urban emissions have been reduced in the period between 2016-2018 (Report on Greenhouse Gas Emissions in DKI Jakarta 2019). In 2018, an emission reduction of 9,341,783 tons CO2 was achieved, adding up to 26.5 percent of what has been targeted for the year 2030 by Regulation 131/2012. Although the city shows progress in reducing GHG emissions, a high commitment is still needed to achieve the targets state in Regulation 131/2012.

With regards to climate change adaption measures, Jakarta has made a considerable progress as well. For instance, 70 per cent of 1949 absorption walls to handle inundations and floods have been realized already (C40 Jakarta). Furthermore, the JEDI initiative has been able to reduce flood area from 203km^2 in 2007 to 144 km2 (C40 Jakarta). The effectiveness of measures, in particular with regards to water resource management, depends, however, not only on local governance of the Jakarta region, but also the coordination with other local governments (C40 Jakarta).

Conclusion

In summary, to reach its provincial GHG emissions target of a 30 per cent reduction, Jakarta has developed several climate change mitigation initiatives as well as the Green Building Code. Being mandatory for all existing and new buildings and covering cross-sectorial areas, the latter represents an important step towards energy-, water-, and material efficiency as well as landscape management in the city.

22.5 Spotlight: Waste management

Regulation 131/2012, which set up Jakarta's local action plan for GHG emission reduction also includes solid and liquid waste management as one primary area of action. Furthermore, Province Regulation No. 3/2013 sets up the draft "Master Plan for Solid Waste Management in the Capital Special Region of Jakarta". It contains three main goals:

- The development of Jakarta into a clean and modern city
- The development of a "Clean Culture Society", meaning that waste management is also supported by the population
- The provision of qualitatively sophisticated waste management services

Moreover, the "essence of the plan is a solution that prioritises waste prevention by reducing waste at source level as mandated in Province Regulation No. 3/2013" (EP&T and DIM 2017). Recycling and waste treatment in Intermediate Treatment Facilities shall help to reduce the quantity of residues and decreases the problem limited capacity of landfills. There are four cornerstones of the Jakarta Master Plan:

- Waste Prevention: More efficient waste management facilities, higher recycling levels and closer cooperation among authorities and communities shall help to achieve the target of a 10 per cent waste reduction by 2017, a 15 per cent reduction by 2022, 20 per cent by 2027 and 30 per cent by 2031. "Waste Banks" play a crucial role in that locals are disbursed financially for depositing waste at local waste banks. They are "informal community-based establishments for collecting sorted inorganic waste that has economic value. Waste banks are set up in neighbourhoods typically for about 1000 residents (…). Bank customers bring all non-organic waste to the banks where it is treated like a deposit" (Worldbank 2018).
- Source separation and waste transport: A container system for different types of waste shall be introduced (e.g. by 2031 there shall be five categories of residues: organic, reuse, hazardous, recycle and residue waste)
- Location of waste transfer stations, including four intermediate treatment facilities, which are waste-to-energy facilities, producing electricity for sale
- Availability and selection of new sites for final waste disposal
- Outsourcing of waste management operations to the private sector (e.g. waste collection services, waste transport and treatment in intermediate treatment facilities etc.)

Outcomes

So far, Jakarta has achieved progress in the following fields:

- In 2016, there were 419 waste banks in five administrative districts in Jakarta, collecting 239 tons of generated waste in the same year. Although this proves that waste banks, besides of having an educational effect on the population, are indeed working in practice, there is still efficiency potential. In 2016, for instance, the 239 tons of collected waste corresponded to only 0.01 per cent of total waste collected. EP&T and DIM (2017) show that in 2016, 6,989 tons of waste were generated in total in Jakarta on a daily basis, while only 6,561 tons of waste were transported to the Bantar Geban Landfill. That means, 428 tons of waste, hence around 6 per cent of generated residues, were not transported from Jakarta to the Bantar Gebang Landfill due to the lack of coverage of waste collection services (especially poor areas are not covered), the lack of transport equipment (e.g. waste trucks), illegal dumping sites in North Jakarta (EP&T and DIM 2017). Moreover, the Bantar Gebang Landfill has reached its maximum capacity and currently, there are "no plans to find a new site for the final waste disposal, so eventually there will be a crisis when it becomes impossible to deposit more waste at the Bantar Gebang Landfill" (EP&T and DIM 2017).
- Jakarta's waterway waste infrastructure is working efficiently in terms of monitoring and measuring the volume of waste extracted from its waterways. "Capturing such data and using it monitor progress on efforts to reduce plastics consumption and disposal into the city´s waterways is an effective step in halting land-based leakage of waste and plastics, particularly, to the coast and the sea" (Worldbank 2018).
- Waste-to-energy technology is planned to be implemented and promoted in Jakarta to improve the problem of waste management in the city
- With regards to waste collection points, Jakarta possesses 71 transfer stations and 761 waste collection points. However, there is a huge discrepancy to the number of stations that should be actually established. According to the regulations, there should be instead 247 transfer stations for each respective sub-district and around 3,000 collection points (EP&T

and DIM 2017). Hence, there is potential for more efficient waste collection system such as more waste collection points, decreasing the distance from the settlements and hence, optimizing the incentives to dump waste into official waste collection points.

Conclusion

The government of Jakarta has developed various regulations with regards to urban waste management. It also implemented and improved various measures at a local level such as waste banks or the establishment of waste collection points. Nevertheless, there is still potential for improvement, in particular with regards to the question of final waste disposal, waste transport infrastructure and the establishment of new landfills.

23 Successful approaches and their reasons

This chapter provides

- a summary of successful plans, policies, measures and other interventions to tackle challenges to protect the urban environment. The summary is based on the twelve spotlights (two per country).
- an analysis why those cases were successful. The analysis takes into account the efforts from the national counterparts and the interaction of policy levels. It examines to what extent the environmental challenges that were identified as well as the political measures that were introduced on a national scale, translate to the local level. To be specific, it analyses how the national approach influences the identification strategies and the implementation of political actions in the corresponding cities, presented in the previous chapter, which synergies exist and to what extent the local and the national approaches differ in the respective country.

23.1 Success in Brazil

Since the 1970s, Brazil has introduced regulations, which are still in force, that have contributed to the improvement of environmental conditions in cities such as the National Air Quality Programme (PRONAR, 1989) and the Programme for the Production of Biofuels (ProAlcool, 1975). Moreover, the Rio de Janeiro Earth Summit, the UN conference hosted by Brazil in 1992, kick-started a process of institutionalisation of environmental policies, which together with the political stability, a clear environmental agenda and the economic growth of the late 90s and 2000s led Brazil to become an exemplary case with regards to environmental policy, especially related to climate change.

Thus, in 2010, in its Nationally Determined Contributions (NDC), Brazil committed to reduce its GHG emissions by 37% below 2005 levels by 2025. For the achievement of these ambitious targets, the Brazilian government published the National Plan for Climate Change (NPCC) in 2010, which comprised 8 sectorial plans, which were designed in more detail and directed towards 8 different sectors that went from Urban Mobility to Deforestation and Agriculture. These plans were accompanied by big financing lines, to which local governments had access and thus influencing the policies at the local level. Moreover, in order to enhance the institutionalisation process, several bodies were created at the national level, in particular relevant for this analysis, the Climate Change and Forests Secretariat of the Ministry of Environment (MMA) and the Ministry of Cities. The first one was in charge of coordinating all climate change related policies and the second one in charge of creating a channel between the local and the national level.

These two institutions have undergone several changes under Jair Bolsonaro's administration (2019 – present), reducing significantly their power and capacities to formulate and implement policies, including the establishment of environmental standards and guidelines. This is just an example of how the change of priorities in the political agenda of the current national administration is threatening the process of decades of institutionalisation of environmental policies in Brazil. The impact of Bolsonaro's political agenda for facing the urban environmental challenges in Brazilian cities is still unknown. Nonetheless, it is worth noting that the process of institutionalisation of environmental policies not only created a sound regulatory framework difficult to neglect, but it also contributed to the creation of a critical mass of technicians and professionals, both at the national and the local level, that continue to work towards sustainable development in Brazil. Furthermore, the fact that the national government has put the

environment low in its priorities list has given the local governments the responsibility to continue the process that started decades ago. Belo Horizonte is a good example of this.

Already in 2006, the city of Belo Horizonte established the Municipal Committee of Climate Change and Eco-efficiency (CMMCE) with the aim of generating local mitigation and adaptation policies to address the impacts of Climate Change. The CMMCE is a collegiate and consultative body comprised of representatives of the Municipal and State Government, civil society, NGOs, private sector and academia, which has the goal of supporting the implementation of the Municipal Policy for Climate Change of the City of Belo Horizonte. It acts as liaison between public policies and private initiatives and works cross-sectorial.

The CMMCE also promotes the participation of Belo Horizonte in important national and international collaborative networks, especially those focused on the actions of cities or local governments in facing climate change such as ICLEI, Carbon Cities Climate Registry, World Bank, WWF Brazil, CDP, WRI, UN-Habitat, ITDP, GCoM, among others. Through international cooperation, a number of bilateral and multilateral partnerships are being carried out, along with international funding agencies, which contribute to the improvement and advancement of municipal climate policy. The existing relationship with international bodies and most of all financing sources reduces the local dependency on national funding mechanisms for sustainable urban infrastructure, which could be significantly reduced depending on the political priorities and the economic conditions of the country.

The longstanding institutionalisation process of environmental policies in Brazil appears to play a key role. This has led to a set of laws, regulations and enabling conditions, as well as engaged professionals and technicians that enable the continuation of environmental policies despite adverse political conditions. Belo Horizonte has a similar set of long-term strategies, master plans and laws in place and the technical staff to push the processes forward despite changes in the political agenda. The international partnerships built over the years increase the stability of the commitment. It remains to be seen to what extent the Bolsonaro's regime would affect this stability.

At the same time, such ambition and approaches are no assurance for successful implementation. Despite the quality and comprehensiveness of the plans, the case study about sustainable urban mobility in Belo Horizonte has shown, that there is still a significant gap between targets (as set in urban strategies) and implementation of consistent bundles of policies. The political will and the financial resources for its implementation are still lacking on both the national and the local level.

Success factors

For decades, Brazil identified various highly significant environmental challenges, including social inclusion, climate change mitigation, land sealing and soil degradation, air pollution and sustainable mobility, created the regulatory frameworks to face them and did significant progress in its implementation. Something similar happens with regards to waste management, public health and water pollution considered as relevant challenges. Adaptations to climate change as well as the loss of biodiversity, on the other hand, were defined as insignificant challenges, as despite of having policies in place, the implementation has not started yet.

On a local scale, the case of Belo Horizonte shows that challenges which are identified as significant on a national scale are translated to the urban strategies. This becomes particularly evident when examining the two spotlights that were presented, namely climate change mitigation and sustainable mobility (to tackle both climate change and air pollution). Both fields are highly relevant for both the city and the national level. Both fields show significant progress.

Table 32: Comparison of priorities in Brazil

Field of activity	Brazil	Belo Horizonte
Air pollution		
Climate change and its effects		
Water pollution		l.e.
Loss of biodiversity		l.e.
Land degradation and deforestation		l.e
Waste generation and management		
Sustainable Mobility	l.e.	

Source: Own illustration, Wuppertal Institute.

Ch: National challenges to protect the environment at the urban level:  =very significant;  =significant;  = neither significant nor insignificant;  = insignificant;  = very insignificant l.e.= less elaborated

PP: National political priorities to protect the environment at the urban level:  =high;  = neither high nor low;  = low; l.e.=less elaborated

Moreover, the case study proved that synergies exist regarding the identification of most relevant environmental challenges. Table 20 listed the most significant policies of Belo Horizonte, which tackle the areas of climate change mitigation, air pollution and biodiversity. All of them are also classified amongst the most urgent fields at the national scale.

Waste management appears to be a special case. Although waste management is not positioned high on Brazil's national agenda, it is included in almost every cross-sectoral policy of Belo Horizonte (see Table 20). Hence, it is possible to identify a clear difference between the national and the local levels and to conclude that Belo Horizonte is proactive regarding municipal waste disposal.

A further factor of success was the local administration's capacity, i.e. knowledge, training and experience of staff in the responsible teams. It is the result of a clear institutional framework that facilitates working on a specific agenda independently from the mayor and political situation.

Finally, it is worth noting that the success story of Belo Horizonte might not be the case of all municipalities in Brazil. Brazil is one of the most unequal countries in the world and its inequality is strongly reflected in the Brazilian territory. Belo Horizonte is located in the wealthiest part of the country, the Southeast region, together with São Paulo and Rio de Janeiro. However, during the process of institutionalisation of environmental policies, the funding was made available for all cities and their capacities were enhanced in such a way that the number of cities from other regions of Brazil implementing sustainable development policies increased significantly.

23.2 Success in Russia

On the federal level the topic of environmental protection in cities is currently defined by a number of legislation acts, and two overarching national projects (those are strategic development programs for particular areas and specific national goals for 2030) - the national project "Environment" and the national project "Housing and Urban Environment". The overall aims of the projects both tackle current issues, like the urban air and water pollution, but also

try to design future vision for further development of urban territories, both in quantitative and qualitative aspects. Within the framework of this urban development initiative, nation-wide expert organizations (such as Strelka) have developed new standards, indicators and rules of quality of urban environment, which, despite their unifying value, also arouse controversy because of the "top-down" approach to their implementation. On the regional levels these plans are being realized as federal programs, but are also supported with regional/local legislation, including general plans, master plans, etc. Overall, further urban territorial development usually reflects the balance of power between the three major stakeholders: local business, administration and communities of citizens, with the latter beginning to play a larger role in recent years.

Overall, both global agenda in the area of sustainability and climate change and local Russian drivers for the topic are pushing for more reforms and changes both in the environmental and urban planning policy, with the latter one being more resistant and conservative. Still, on the federal and more often on the regional levels, many elements of environmental and urban strategies, policy implementations and planning are often ill-connected with each other, lacking a holistic comprehensive approach, that would bring all elements of urban infrastructure (including energy, transportation, housing, water supplies, green infrastructure, etc) into one sustainable and resilient system, and there is relatively little cross-sectoral approach in political thinking and action.

But there are also success stories in Russia without drawbacks. The analysis reveals that far-reaching success in the Russian Federation includes the combination of national priorities and local creative possibilities.

One example is the implementation of several policy measures in Moscow to reduce air pollution following the ambient air standards set be the national government. Moscow's work to drive down air pollution includes all relevant sectors, namely energy generation, transportation, city planning and management of green zones. Measures are, amongst others, moving industrial facilities out of the city, modernization of the Moscow oil refinery, tree planting programs, and the development of an air monitoring control network with real-time air quality information.

Similar patterns can be found in the field of sustainable transport. The Transport Strategy of the Russian Federation sets long-term state transport priorities, including transport system development goals and parameters for the regulation of transport operations. Amongst others, it aims at providing affordable, high quality public transport services in line with social standards and includes dedicated funding. Other fiscal incentives exist. The city of Moscow receives federal funding in line with the strategy and other financial sources, while also bringing a lot of its own budget money, being one of the wealthiest regions in the country. Amongst others, Moscow is continuously extending its public transport network. Some of the main objectives are to connect deserted industrial zones and inhabitants with the city centre, to contribute to a reduction of private vehicle usage and to reduce traffic congestion. There has recently also started a discussion in some cities about free public transport.

Success factors

The comparison of political priorities on the Russian national and the local level in Moscow reveals that top national priorities are mainly replicated on the local level. Air pollution and water pollution have been tackled in the recent years in Russia, and Moscow is implementing corresponding local action. However, Moscow also sets its own priorities. In some cases, the local ambition reaches further than the national, namely with respect to climate change and its effects, urban green space and noise pollution. A likely reason is the status of Moscow as biggest and richest city (and also the region) of the Russian Federation. Moscow most likely faces

challenges that are more urgent than in other cities and the city also has more resources to tackle these challenges.

Table 33: Comparison of priorities in Russia

Field of activity	Russia	Moscow
Air pollution		
Climate change and its effects		
Water pollution		
Urban green space		l.e
Waste generation and management		
Noise pollution		

Source: Own illustration, Wuppertal Institute

Ch: National challenges to protect the environment at the urban level:  =very significant;  =significant;  = neither significant nor insignificant;  = insignificant;  = very insignificant l.e.= less elaborated

PP: National political priorities to protect the environment at the urban level:  =high;  = neither high nor low;  = low; l.e.=less elaborated

Other cities are also trying to follow Moscow's example, however, often lack sufficient resources (both financial and administrative). Also various cities across the country face various challenges: in the south of the Ural and Siberia region many cities still have an industrial base and coal generation for energy and heating, so their approach to fighting air pollution would have to be different, and many of them are still stuck not doing much. Northern cities built on permafrost are particularly vulnerable to the negative impact of climate change. Many Siberian cities suffer from smog and other negative effects resulting from the forest fires around them.

In conclusion, a common successful national strategy to foster environmental protection at the local level is to set targets and providing monetary support. Factors of success are:

- Clear process targets
- Stakeholder commitment (local business, civil society) and securing public support
- Monitoring of compliance connected to incentive schemes
- Coherence of other national policies such as fiscal incentives which encourage the same/similar objectives
- Available financing
- Transparency and accountability of city/regional administrations, also with regard to their environmental policies

23.3 Success in India

The success in India results from joint efforts of many different institutions on different policy levels. India has climate action plans and policies at multi-level governance to tackle urban environmental challenges. The central top-down policies are aligned with bottom-up approaches in terms of defined and supportive roles and responsibilities. The central government holds the main responsibility of climate policy including financial planning and

multilateral negotiations. It notifies state governments to formulate plans, policies and take actions that further co-ordinates with local government. State and local government in India create their own initiatives to take action. In the absence of publicly-elected mayors in some cities, policymaking and funding for local governments are controlled by the states. NITI Aayog, a policy 'Think Tank' of the Indian government also provides directional and policy input, and technical advice to the centre and states.

India targets are to reduce the emissions intensity of its GDP by 33 to 35 % by 2030 compared to 2005 levels, as mentioned in the country's INDC. The main sectors of interventions to reduce GHG emissions are on increasing renewable energy, promotion of clean energy, enhancing energy efficiency, climate-resilient urban centres, and sustainable green transportation networks. Some of the key policies addressing climate change in India are National Action Plan on Climate Change (NAPCC), State Action Plan on Climate Change (SAPCC), Smart Cities Mission, and National Urban Transport Policy (NUTP) 2014. Smart Cities Mission, initiated by national government for an area-based development for city regeneration with smart solutions, provide funding for implementation. Kochi is one of the 20 smart cities. Kochi Municipal Corporation (KMC) has developed a roadmap and action plan, such as building energy and resource efficiency, sustainable transport actions enhancing public transport, and smart solutions for waste management (such as waste to energy, waste to compost, wastewater to be treated, and recycling and reduction of construction & demolition waste). Kochi received funding to implement some of the projects such as on housing, eco-restoration and water management solution. Another notable national level initiative to provide urban services (e.g. water supply, waste management and urban transport) is the Atal Mission for Rejuvenation and Urban Transformation (AMRUT). State distributes the funds to implement the projects in cities. 500 cities have received the support from AMRUT so far.

Regarding air pollution control, the Central Pollution Control Board (CPCB) provides technical service to MoEFCC and takes actions to improve the quality of air and to prevent, control, or abates air pollution in the country. The Environment Pollution Prevention & Control Authority (EPCA), a supreme court-appointed environment watchdog for the National Capital Region, carries out activities to protect and improve the quality of the environment and prevent, control, and abate environmental pollution. State and local government in India create their own initiatives to minimise air pollution. For example: Kerala state pollution Board (KSPCB) carries out cross-sectoral actions to tackle environmental challenges in Kochi. The implemented measures have reduced air pollution and they are monitored from sixteen monitoring locations, including industrial, commercial, and residential zones of Ernakulam (Kochi). The city also prioritises the stakeholders' engagement in air pollution reduction actions. A consultative multi-stakeholder meeting on Air Quality Solutions in Kochi brought together officials from the Government, major research institutes, and other stakeholders including medical practitioners to discuss an inclusive strategy for Air Quality Solution for Kochi.

The MoEFCC also published several rules for waste management too, such as Plastic Waste Management Rules, Solid Waste Management Rules and Construction and Demolition Waste Management Rules. These rules designate municipal authorities as the legal entity to manage waste in its jurisdictions. According to the Indian Constitution, the responsibility for solid waste management is under the state government and the urban local bodies (ULBs). Municipal authorities, e.g. KMC, take responsibility for implementing these rules and developing infrastructure for collection, storage, segregation, transportation, processing and disposal of municipal solid waste (MSW). Since 2008, it is mandatory to segregate waste as source in Kochi and defaulter can be fined depending on the quantum and quality of waste. The collaborative

effort of Kochi municipal corporation has led to achieving source segregation and significantly reduced the overall waste transferred to landfills.

To support sustainable built environment, mainly considering buildings and surrounding environment, India also has national building standards - Green Rating for Integrated Habitat Assessment (GRIHA). GRIHA incentives are adopted in many states, such as Himachal Pradesh offers an additional floor area ratio (FAR) for GRIHA rated buildings, and Haryana includes GRIHA as a requirement for financial assistance as a part of solar cities programme.

Success factors

The most pressing urban environmental challenges in India, such as climate change mitigation and adaptation, air pollution, water pollution and waste generation, have been addressed at national, state as well as city level through regulatory framework and supportive policies and actions. The environmental challenges and responding measures vary according to the cities in India. The selected case in Kochi shows that the city has been highly active in various urban development programmes and activities to protect the urban environment, mainly to tackle air pollution and waste generation.

Table 34: Comparison of priorities in India

Field of activity	India	Kochi
Air pollution		
Climate change and its effects		
Water pollution		
Land sealing		
Waste generation and management		

Source: Own illustration, Wuppertal Institute

Ch: National challenges to protect the environment at the urban level:  =very significant;  =significant;  = neither significant nor insignificant;  = insignificant;  = very insignificant l.e.= less elaborated

PP: National political priorities to protect the environment at the urban level:  =high;  = neither high nor low;  = low; l.e.=less elaborated

To respond to polluted industrial cluster of Kochi, Kerala state pollution Board (KSPCB) is carrying out cross- sectoral actions, which include industrial pollution control, monitoring arrangement and demarcation of areas, as well as developing common effluent treatment plant, common pipeline for treated effluent, electricity supply improvement and continuous monitoring of water and ambient air quality. The Kochi City Development plan (CDP) provides systematic plans for a sustained growth of the city and its environment. It serves as a basis to sanction funding from national government.

Kochi's air quality is regularly monitored through various located stations and satellite data, which shows that stringent measures are still required on sustainable transport and on controlling industrial pollution. In terms of waste management, the case of Kochi initiated by KMC shows how source segregation, composting, stringent legal system coupled with multi-stakeholder participation leads to effective waste management in urban places. The households are engaged in three types of waste removal practices, such as household treatment of waste, using Self-Help Group (Kudumbashree/ Sevanasree) services to remove waste, and discarding on the street at a designated area. The collaborative effort of Kochi municipal corporation has

led to achieving source segregation and significantly reduced the overall waste transferred to landfills. The biodegradable fraction is treated at the source level through composting and bio methanation (Biogas plants). Kochi is also going to implement waste to energy plant with the capacity to process 800 tons of waste daily. This is fully supported by the KMC, state government and national government. The power generated from this will be purchased by Kerala State Electricity Board (KSEB).

KMC also has an institution functioning as the research and development wing, the Centre for Heritage, Environment and Development (c-hed), sanctioned by the Kerala State government and established by the city administration. One of the key focus areas of c-hed is to envisage and implement various measures focusing on the environment conservation of Kochi. This institution is active in pursuing national and international projects/activities in a collaborative manner, which allows the city on peer-to-peer learning and capacity building actions. C-hed has established a partnership agreement with the national government's National Institute of Urban Affair (NIUA), which will support developing sustainable urban development projects for Kochi. Therefore, the engagement of environment leaders of KMC brought together local and international communities to carry out and support environmental protection activities.

To summarise, the local government of Kochi plays a key role to carry out the climate actions and the enabling factors for the actions include:

- Supportive state-level actions/policies, including financial assistance
- Responsive local government representatives
- Supportive local communities
- Monitoring of activities
- International and inter-city collaboration

23.4 Success in China

The environmental governance structure in China exhibits a complex and mixed nature. On the one hand, given the hierarchical structure in China, policies are implemented in a top-down manner, i.e. from the responsible ministry reaching down to its line offices at different administrative levels, including municipal bureaus. On the other hand, the municipal environmental bureaus are also a part of municipal governments. The latter has a large degree of decision-making autonomy of local development and sometimes selectively implement national environmental policies, considering their local needs. This dual structure reflects the complexity of urban environmental governance and sometimes leads to ineffective implementation of national environmental protection strategies, if local government pursues local economic performance at the cost of environment. However, the promotion decision of local officials still remains at the central government, which uses binding targets and cadre evaluation system to provide local leaders incentives to fulfil national mandates. The central government sets clear binding targets for provinces (provincial cities), which further distribute the targets to subordinate administrative levels. These targets are written into the local officials' annual responsible contract and are important criteria for their promotion. They have "veto power", which means that all achievement of a local leader will be disregarded in their cadre evaluation if these targets are not met. Failure to fulfil these targets can also lead to non-approval of new large investment projects (Kostka, 2014). This applies to urban environmental protection in general, as analysed for Beijing and in more detail for air pollution and water

issues earlier in this report. Such issues are moved on the priority lists of local leaders, despite their strong will to seek for high GDP growth rates.

Except for the vertical integration, both water and air issues are characterized as cross-sectoral and cross-regional. Thus, for example, for water pollution, Beijing City sets up a Leader Group of Water Pollution Control to coordinate all efforts among departments and different districts (Beijing Government, 2015). At the regional level, collaboration mechanisms are established for water and air issues in the Beijing-Tianjin-Hebei region. The "Collaboration group" of regional air pollution prevention and control was established since 2013, which was led by Beijing City and encompassed different ministries and other six provinces (including provincial level cities). It was reorganised to a „Leader Group" in 2018, which is now led by the State Council and includes nine ministries and seven provinces. The latter is more powerful than the former, given the leadership of the national government. The Group develops the regional strategies and action plans for air quality improvement and enforcement mechanisms, guides and supervises the implementation, coordinates joint actions for severe air pollution response and various other related actions among the different provinces (People, 2018). Besides, peer-to-peer support system has been established, e.g. Beijing provided both technical and financial support to two cities in Hebei Province to control coal-fired boilers (UN Environment 2019). In water management field, regional coordination mechanism is being developed for water resource allocation and water ecosystem recovery (Beijing Government, 2016).

Thus, a strict implementation from the top national level down to the local level can be very successful, as the cases of air pollution reduction and water management in Beijing show. Overall, the success lies in the governance structure, i.e. the combination of vertical and horizontal integration (cross-sectoral and cross regions). In addition, an effective policy package as well as economic and human resources of the capital region play a significant role.

In 2012, the central government issued "the Views of the State Council on Applying the Strictest Water resources Control System". It includes Three Red Lines that sets binding limits of water consumption, use efficiency, and water quality. The binding targets for 2030 are reinforced by a set of milestones for 2015 and 2020. To achieve the targets and milestones, the document proposed the establishment of clear responsibilities of water resources management and an assessment system, including principle indices for the development, utilization, conservation and protection of water resources, to be a part of local official's evaluation system.

Beijing has implemented the national water resource management. To reach water use efficiency targets, both command-and-control and market-based instruments have been implemented. To honour efforts, the central government has designated Beijing as a pilot city of the water resource tax reform in 2018. The national pilot program had been launched in 2016 to replace the water resource fee system with a tax.

Similarly, air pollution is a major concern in Chinese cities. In the winter of 2012, some regions experienced smog episodes with real-time PM2.5 levels exceeding 1,000 µg/m^3. Since 2013, Chinese government has „declared" war against air pollution. The State Council issued the Air Pollution Prevention and Control Action Plan (APPCAP), which specifies a set of targets for air quality by 2017. The plan pledges to 1) reduce annual average PM2.5 concentration in three key metropolitan regions (Beijing-Tianjin-Hebei region, the Yangtze River Delta, and Pearl River Delta by 25%, 15%, and 10%, respectively); 2) reduce the concentration of PM10 by 10% in all cities; 3) reduce PM2.5 levels from 89.5 µg/m^3 in 2013 to 60 µg/m^3 in Beijing (Central People's Government of the P.R.C 2013a).

In response to the APPCAP issued by the national government, Beijing City had made tremendous efforts to improve its air quality. The municipal government issued a „Five-Year

Clean Air Action Plan (2013-2017)“ with the targets in line with the National Plan. To realize this goal, about 60 measures of air pollution prevention and control were implemented in energy, transport, and industry sectors (Beijing Government, 2013). The implementation of the Action Plan (2013-2017) had significantly improved the air quality of the city and resulted in PM 2.5 concentration of 58 µg/m³ (a 34.5 % reduction compared to 2013 and lower than the national targets) and 226 days with good air quality in total (50 days less than that of 2013) (Beijing Government, 2018a). In 2018, the local government further issued the “Three-Year Action Plan for Blue Sky ”, which aims to reduce the concentration of Nitrogen Oxide (NOx) and Volatile Organic Compound (VOC) by 30% and number of severe pollution days by more than 25%, compared to the level of 2015 (Beijing Government, 2018b).

Success factors

As can be seen in table 35, China has ambitious targets and policies for many fields of activities; and these targets are implemented at the local level in Beijing. The fast growth and economic prosperity of Beijing came along with a deterioration of the environment. As a consequence, policy makers have substantially intensified their efforts to resolve those challenges. Similar patterns can be found all over the country.

The analysis also shows that the Chinese top-down approach enables the alignment of priorities on different policy levels, although challenges and priorities in other cities, which may be less prosperous, smaller and may have different geographic conditions, could be different.

Table 35: Comparison of priorities in China

Field of activity	China	Beijing
Air pollution		
Climate change and its effects		
Water pollution		
Loss of biodiversity/ Urban green space		
Waste generation and management		

Source: Own illustration, Wuppertal Institute

Ch: National challenges to protect the environment at the urban level: =very significant; =significant; = neither significant nor insignificant; = insignificant; = very insignificant l.e.= less elaborated

PP: National political priorities to protect the environment at the urban level: =high; = neither high nor low; = low; l.e.=less elaborated

Another key factor of Beijing’s successful improvement of air and water quality is the comprehensive policy package covering different key sectors.

To improve air quality, Beijing developed a range of policies and measures (UN Environment 2019):

- Targets setting and overarching strategies: e.g. developing „Five-Year Clean Air Action Plan (2013-2017)“, “Three-Year Action Plan for Blue Sky ” (2018-2020);
- Local legislation: issuing “Ordinances for Prevention and Control of Air Pollution”, which is a locally tailored law based on national legislations;
- Command-and-control measures: e.g. closing down and stringently controlling coal-fired power units, limiting vehicle license plates using a lottery system;

- Standards: tightening vehicle emission standards and fuel quality standard, tightening air pollutants emission of boilers;
- Financial incentives: providing subsidies for purchasing passenger electric vehicles, for renovating industrial boilers, for high-pollution industrial enterprises to implement air quality control measures;
- Information: issuing weekly air quality reports and launching various public awareness-raising events through different media.

In addition to the numerous policy instruments, Beijing also sets up an integrated air quality monitoring system with advanced technologies and more than 1000 PM2.5 sensors. All these measures had been backed by a significant amount of public budget. For example, the total public budget for implementing the Action Plan of 2013-2017 was amounted to about 5 trillion Yuan (above 600 billion EUR) (Beijing News, 2017). In 2018, Beijing government planned 19 billion Yuan (more than two billion EUR) (GOV, 2018).

To address water challenges, similarly, Beijing government implemented different types of policies and measures:

- Targets setting and overarching strategies: developing a comprehensive strategy to establish water saving society system;
- Local legislation: issuing locally tailored "Ordinances for Prevention and Control of Water Pollution";
- Command-and-control measures: e.g. stipulating water consumption quota system for different administrative districts and key sectors, stopping high pollution industrial projects;
- Market-based instruments, e.g. introducing progressive water resource fee system, being a national pilot city of water resource tax, which imposes higher tax on water intensive users and exploitation of groundwater (GOV, 2018b);
- Financial incentives: e.g. providing subsidies for consumers to purchase water-saving appliance.

Besides, the government has continuously strengthened monitoring capacity. For example, there are almost 1000 groundwater monitoring points. The monitoring density is one point per 7.5 km^2, which is most dense in China (Beijing Youth,2020).

Furthermore, water quality improvement in Beijing also relies on significant investment in infrastructure. During the 13th Five Year Plan period, in total, the municipal government planned to channel more than five billion Yuan (more than 60 million Euro) for constructing and retrofitting wastewater treatment plants, wastewater pipelines, and reclaimed water plants (NDRC, 2016).

23.5 Success in South Africa

South Africa's success in addressing environmental challenges can be attributed to its cooperative governance approach. Environmental authorities at the national, provincial and local level are in charge of identifying, defining and addressing environmental problems by implementing the corresponding policies (South African Government 2020).

The key players of national environmental policies include the Department of Environmental Affairs as well as the Department of Water Affairs. Besides the definition of political instruments,

they also play a vigilant role regarding the compliance with environmental measures at all other governmental levels. They have, due to the cooperative governance system in the country, however, not exclusive competences in all areas (South African Government n.d.). Considerable decision-making authority is transferred to the provincial and to the local level. So a part of the success in Cape Town can be explained with the principle of subsidiarity.

An impressive example is air quality management and pollution prevention. It is defined in the South African Air Quality Act by the national authorities; it transfers, however, the executive authority to municipal governments who are required to implement policies such that they meet the national air quality standards. Cape Town shows not only efforts to accomplish the national ambient air quality standards defined by the Department of Environmental Affairs, it also encourages more ambitious policies to improve the urban air quality, for example by promoting public transport options and sustainable mobility infrastructure (see also Five year integrated development plan 2017-2022, City of Cape Town 2017), or by ensuring compliance through penalties and strict monitorization (see also City of Cape Town 2016). Policies are set on key principles including public participation – ensuring the public acceptance of national as well as local environmental policies in the city. In cooperation with the district authorities, the municipality has developed several service points as well as online platforms where citizens have the possibility to issue pollution complaints or inform how to decrease pollutant behavior. Monitoring and enforcement strategies contribute to success in this field. Air quality standards in Cape Town mostly meet the National Ambient Air Quality standards and are the positive result of ambition at multiple governance levels.

Another part of success in South Africa is the sheer pressure to be active. South Africa and particularly the cape region belong to the world´s most biologically diverse areas. At the same time, water is a scarce resource in South Africa, which is particularly the case for Cape Town. The city continues to experience extreme droughts. 91% of South Africa´s surface is classified as semiarid area and is susceptible to desertification. Politically this can be explained as the legacy of the apartheid, which lacked an adequate system of land ownership and land tenure laws.

Projects regarding water management in Cape Town are based on the city's Water Conservation and Water Demand Management Strategy (WCWDM). The success of the strategy is globally known. The measures were defined as good practices and as such integrated as bottom-up policies into provincial and national guidelines (Sinclair-Smith & Winter 2018). Cape Town's efforts in progressing water management and preventing water pollution, has not only contributed to the identification of water pollution and scarcity as one of the most prominent environmental challenges in the country, but it has also encouraged the implementation of corresponding counter-measures by regional and national governmental authorities. As a forerider in water management policies, Cape Town has received the C40 Cities Award for best climate change adaptation at the Paris COP21 climate negotiations (C40 Cities, 2015).

South Africa's capital is, hence, an example of how top-down as well as bottom-up policies are efficiently implemented in the country's national, regional and local environmental policy agenda. The priority that is given to political fields as well as the effective implementation of policies does not depend on whether the associated policy is based on a bottom-up or top-down approach but rather on a mutual learning process of the different governance levels and on the effective cooperation between them. Cape Town's success stories are a result of the administration's capacities and financial resources resulting in ambitious approaches.

Success factors

South Africa's cooperative environmental governance has proven that it can be successful in certain areas of intervention, namely in air pollution reduction.

With regard to water management, Cape Town sets its own priorities, independent of national guidelines, such as in the area of water management. The city's efforts may be explained by its status as South Africa's legal and administrative but also economic capital, attracting financial investments and political attention. Another reason may lie in the city's challenges regarding environmental protection.

Furthermore, table 36 shows that South Africa has ambitious political targets for several areas, including climate change adaption and -mitigation, air pollution and water pollution prevention, as well as sustainable transport. The analysis also revealed that the country's cooperative governance structure translates national priorities onto the regional and local level and vice versa; since good practices are formed and implemented by all levels of governance, the cooperative nature of South Africa's governance can ensure a sustainable and efficient multi-level learning process.

Table 36: Comparison of priorities in South Africa

Field of activity	South Africa	Cape Town
Air pollution		
Climate change and its effects		
Water pollution		
Loss of biodiversity/ Urban green space		
Waste generation and management		
Desertification		l.e.
Sustainable Transport		

Source: Own illustration, Wuppertal Institute

Ch: National challenges to protect the environment at the urban level:  =very significant;  =significant;  = neither significant nor insignificant;  = insignificant;  = very insignificant l.e.= less elaborated

PP: National political priorities to protect the environment at the urban level:  =high;  = neither high nor low;  = low; l.e.=less elaborated

Due to its paradigmatic approach in addressing air pollution and water management, the following will list several factors that contribute to Cape Town's successful combat strategies in the respective fields. Regarding air quality control, Cape Town's policies are based on the following instruments:

- Quality Standards: local standards are leaned on national ambient air quality standards
- Strict enforcement: e.g. penalty system under the Air Quality Management Plan (City of Cape Town 2005), combined with the enforcement power "Air Quality Officer" and "Air Quality Management Unit" as a by-law
- Public participation: e.g. Air Quality Officer, Air Quality Management Unit and online platform, to which citizens can report pollution
- Public information: e.g. Air Quality Booklet to which citizens have access to

- Monitorization: e.g. Scientific Services Department, yearly City of Cape Town State of Environment Report, compliance to regulations is monitored by Air Quality Officer and Air Quality Management Unit
- Minimization at the source: e.g. executive jurisdiction at the municipal level, enabling the promoting of public transport and other sustainable strategies based on local needs

Moreover, Cape Town's urban air quality policies take into account the interdependency of policy fields, encouraging a holistic approach in combatting air pollution.

The following factors contributed to Cape Town's success are based on its Water Conservation and Water Demand Management Strategy (WCWDM) programme (City of Cape Town 2007) and include the following:

- Technical improvements: e.g. minimisation of water losses, prolonging life cycle of water infrastructure, pipe replacement programme
- Public awareness: WCWDM initiatives were implemented in Cape Town earlier than in other towns due to public awareness of water scarcity problems in the region
- Market-based instruments: e.g. water tariffs are rising, but based on social criteria; for example, the first 6000 litres of water per month are free of charge to all households
- Monitorization: e.g. monitorization of water losses, effectiveness and scrutiny of political leadership
- Enforcement: e.g. water saving measures, including permanent restrictions on garden watering times
- Public information: e.g. "keep saving water" campaign marketed through different media, "Day Zero" campaign

Financial incentives and initiatives: e.g. innovative approaches for low-income communities which are free of charge for plumbing repairs (C40 Cities, 2015).

23.6 Success in Indonesia

The Indonesian national government has developed vision, plan, policies, and programme, addressing Sustainable Development Goals (SDGs), in response to major environmental challenges, such as handling air pollution, climate change mitigation and adaptation, minimizing water pollution and managing waste generation. Indonesia's Nationally Determined Contributions (NDC) set an unconditional reduction target of 29% of BAU by 2030 and a conditional reduction target of up to 41%, with the support from international assistance on financing, technology transfer, and capacity building. However, the compliance and enforcement of environmental regulations is still an issue, such as on waste management, and some national targets are less stringent too, for example, air quality standards are less stringent than global WHO guidelines. On the other hand, some of the efforts at the provincial and local government levels are noteworthy that has introduced more ambitious emission limit and lead-by-example policies, that can facilitate clean air and mitigate climate change. The success factors in Indonesia results from respective efforts from the national and sub-national government on environmental protection.

A joint effort (with interaction and coordination with the various government) would have been more effective, which somehow is affected by political power at the governance level. Indonesia

has made a strong push towards political, administrative, and fiscal decentralisation, giving regional and local political levels much more economic and political autonomy than under the former Suharto regime. As a result, the number of provincial and local regulations and policies has increased. In recent years, there has been a trend back towards the partial centralisation of political powers. As a result, environmental policies in several fields are defined by top-down regulations; e.g. regarding air pollution prevention, in contrast to municipalities which are only allowed to issue bylaws, only provincial governments can introduce more stringent targets than being developed at a national scale (ADB 2010, CAI-Asia 2010). Municipalities have a more executive rather than legislative power in the area of environmental policies. This has created a complex web of governance, which sometimes creates unclear decision-making power hold. However, in order to mitigate the urban environmental challenges identified in Indonesia, an effort from a relatively broad range of actors appears to be relevant, including the national government, local government, and various institutions.

The National Action Plan for Greenhouse Gas Emission Reduction of Indonesia (*Rencana Nasional Penurnan Emisi Gas Rumah Kaca, RAN-GRK*), formulated by BAPPENAS, has the cross-sectoral framework for climate strategy. The main mitigation sectors it includes are forestry, energy efficiency, renewable energy, solid and liquid waste, and transport directly or indirectly contributing to improving air quality. The RAN-GRK is a reference document for GHG emissions in any government development planning. It mandates the provinces to develop and submit a Local Action Plan (RAD-GRK), as well as provides capacity building, budgets, and potential participation in domestic and international markets to local governments to incentivize them to contribute to RAN-GRK's goals. Likewise, the National Action Plan for Climate Change Adaptation (RAN-API), also formulated by BAPPENAS, aims to strengthen support on climate resilience, such as through capacity building, planning and budgeting, and monitoring and evaluation.

The energy-saving action on the national level includes a mandatory Energy Conservation of Government Office Buildings (No. 10/2005), such as for government agencies and regional governments to realise energy-saving measures according to guidelines for energy-efficient building. Indonesia also introduced green building codes in major cities, such as in Jakarta, for sustainable building construction and environment. To respond to the air pollution and emission-related to the transport sector, Jakarta and other major cities have increased the investment in public infrastructure (for example, in mass-rapid transit and light rail transit). Municipalities are supporting active transportation, such as by allocating bike lanes and promoting car-free days. Municipalities are also in charge of district spatial planning through which various environmental challenges can be tackled including air pollution, climate change, land sealing, and land subsidence. Indonesia's effort to sustainable waste management engaging households at the city level is also inspiring. It is a direct form of 'waste to wealth' example in which people exchange waste for small amounts of money and get the amount deposited in waste banks. The development of waste banks not only help engage municipalities and local communities, build awareness among citizens and start developing waste sorting and recovery potential, but also create socio-economic value. By early 2019, Indonesia has 7500 waste banks in 232 regencies/cities.

Indonesia is also active in international cooperation with bilateral (e.g., Germany and Japan) and multilateral institutions to carry out actions on limiting air pollution and climate change through financial assistance or technical support.

Success factors

The identified urban environmental challenges in Indonesia, such as climate change mitigation, air pollution, waste management, water pollution, and green public space, have been addressed at the national and sub-national levels. The provincial-level has introduced more ambitious emission limit values and green building standards, which can facilitate clean air and mitigate climate change. Jakarta has progressively developed various sectoral and cross-sectoral policies for urban environmental protection. These include instruments for emission reduction, resource efficiency, air quality improvement, waste management, and sustainable urban planning (e.g., alternative mobility options such as a bus rapid transit system).

Table 37: Comparison of priorities in Indonesia

Field of activity	Indonesia	Jakarta
Air pollution		
Climate change and its effects		
Water pollution		
Loss of biodiversity/ Urban green space		
Waste generation and management		
Land sealing/soil degradation		l.e.
Sustainable Transport	l.e.	

Source: Own illustration. Wuppertal Institute.

Ch: National challenges to protect the environment at the urban level:  =very significant;  =significant;  = neither significant nor insignificant;  = insignificant;  = very insignificant l.e.= less elaborated

PP: National political priorities to protect the environment at the urban level:  =high;  = neither high nor low;  = low; l.e.=less elaborated

To control air pollution, Jakarta has implemented various regulations on transport emission control. It includes Gas Fuel usage for Public Transport and Government Operation Vehicles, transport management plan comprising the development of a bus rapid transit, a rail-based transportation infrastructure, including a mass-rapid transit, light rail train, and river transportation as well as transportation demand management and parking restrictions.

Jakarta´s climate strategy is embedded in the 2007 National Action Plan (NAP) on Climate Change, forming Indonesia´s cross-sectorial framework to mitigate the effects of climate change. Jakarta has set a stricter target of 30 percent GHG reduction by 2020. Jakarta has also joined the C40 Cities Climate Leadership Group in 2007, which is an association of cities that commits itself to combat climate change. The green building code of Jakarta has saved energy and resources from the built environment.

The master plan of Solid Waste Management in Jakarta has supported waste prevention (e.g., efficient waste management facilities), waste source separation and transport (with waste separating containers), waste transfer stations (to waste-to-energy facilities) and public engagement in waste management operations. In 2016, there were 419 waste banks in five administrative districts in Jakarta, collecting 239 tons of generated waste in the same year. With the waste bank movement, the central Jakarta has decreased waste volume by 35%.

To summarise, the local government of Jakarta fully support carrying out the climate actions, and the factors of success include:

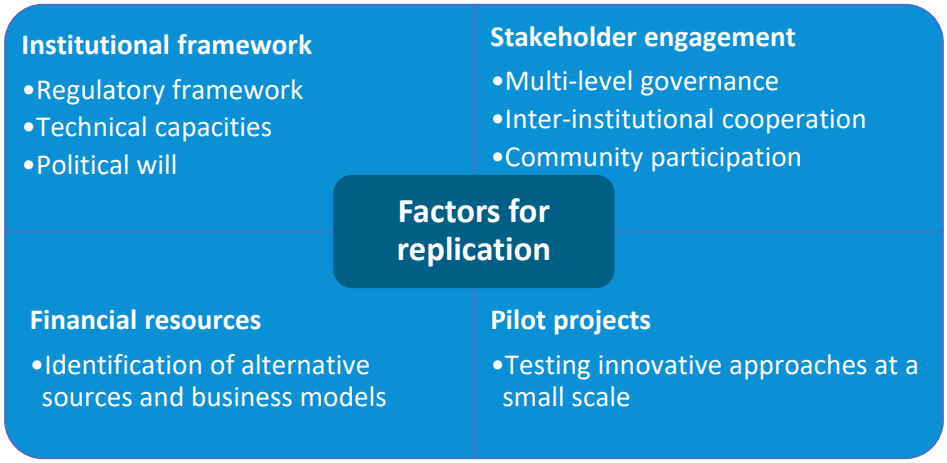
- Supportive local government with the vision to develop Jakarta as a smart city, with the concept of City 4.0 in which the city government is a collaborator and the community is co-creators, enhancing public participation and interaction in climate actions
- Responsive local government representatives: The governor of Jakarta fully support 'Jakarta Urban Regeneration 2030' focusing transformation of policies from Car oriented development to Transit-oriented development, and from Underinvestment in the basic services to Rapid investment in it
- Community Action Plan program, in which citizens work in collaboration with NGOs, think tanks, universities, and the city government, to design and apply their solutions to the city's problems
- Opportunities for private investments in public services (e.g., infrastructure)
- Data collection and monitoring of activities
- International collaboration

24 Potential replication and transferability

Having elaborated on the similarities and differences among the city-approaches of the respective countries, this chapter analyses to what extent these successful local approaches can be replicated in other cities; and which framework is needed to ensure a successful replication. Replicating and disseminating the good practices of the case studies presented in this report is vital to accumulate scientific knowledge, encouraging evidence-based decision-making and effective political measures with regards to a pathway towards sustainable urban development. The first part explains the notion of replication as well as the criteria that should to be fulfilled by the replication cities; the second part of this chapter discusses to what extent the six cities presented above can be used as examples for replication strategies.

Replication in the context of this report refers to an approach or strategy, that is based on an already existing strategy of a pilot city and a city-to-city learning process, taking into account the individual and context-specific characteristics of the respective urban settlement. The case studies' spotlights showed that successful local activities to protect the environment relied on four main factors, namely: a strong institutional framework, stakeholder engagement, availability for financial resources and pilot projects (see Figure 46).

Figure 46: Factors for replication



Source: Own illustration based on case studies, Wuppertal Institute

Institutional framework

A sound institutional framework to address the environmental challenge in question sets the basis for the successful implementation of the necessary policies and measures. For these to be complete, there are three aspects that need to be taken into account. The elements that will be listed below ensure that the policies and plans can be implemented in the medium and long term without fundamental change of direction coming from the political cycle and a different political agenda.

First of all, there should be a comprehensive regulatory framework, both at the national and at the local level, that includes the laws and ordinances, which are binding and thus difficult to modify in the short term, as well as the plans and strategies that provide the legal basis for the implementation of policies and measures.

Second, the technical staff that works in the institutions involved in the implementation of the policies and measures is key. It is not only the technical capacities that these individuals should have, but also the commitment with the plans and strategies, so that their implementation could continue despite changes in the political priorities.

Finally, while these two elements are fundamental to set the basis, the process could be slowed down significantly if there is no political will.

Stakeholder engagement

Another key aspect to take into account is stakeholder engagement. Without the necessary stakeholder involvement, no matter how good the project is, there is a high risk of failure. There are different types of stakeholders that could bring different elements to the table.

For instance, the coordination with the national (and state) level is important, as it could become a very important supporter of the project, legally, politically and many times even financially. Thus, the application of a multi-level governance approach for the pursuit of the necessary measures to mitigate urban environmental challenges at the local level is crucial.

Interinstitutional cooperation is another important factor, which is often disregarded. Public bodies often focus on carrying out their daily operations without putting much thought about the possible linkages and synergies that exist with other bodies, usually from the same institution. This often leads to overlapping and replication of work and thus a waste of the already scarce resources. In this context, coordination among different bodies could not only save resources, align the measures better, but also, when the cooperation happens among institutions from different sectors, provide a more holistic and inter-sectorial approach.

Last but not least, community participation is fundamental for the success of any project. Local support and approval is needed to legitimize public interventions. Thus, the directly affected population should be involved since the beginning and not only through socialization processes, but also contributing with their views and ideas about the project using tools such as community mapping and or design that should somehow be integrated in the final design of the project. This also includes the involvement of different stakeholder groups involved in the project such as civil society organizations, private sector, academia, etc.

Financial resources

The availability of financial resources is key for the implementation of any plan or strategy. The financial resources at the local and national level are usually limited and constraint by the economic situation and the political priorities. Thus, the identification of alternative financial sources from international organisations, as well as the development of cost-effective business models and the introduction of schemes such as public private partnerships is crucial.

It is worth mentioning that despite the funds that have been made available through the Paris Agreement, where developed countries reaffirmed their pledge to mobilise USD 100 billion a year in climate finance for developing countries by 2020, developing countries still face enormous challenges in mobilising financial resources and using funding for the necessary climate change adaptation and mitigation measures (BMUB 2017). This is often due to the lack of capacities and resources for the design and development of bankable projects. However, several international projects are working on building the bridge between sustainable urban projects and green funding.

Demonstration activities / pilot projects

Testing the feasibility of innovative solutions in a Living Lab environment can be a vital step to demonstrate the economic, social and environmental viability of the measures in question. The implementation of pilots in participatory and sector integrating projects at a small scale, such as the neighbourhood level, in order to showcase the impacts of measures to which the population could be reluctant (e.g. bike lanes, pedestrian zones in car-oriented cities), is an important tool to gain public support, engage the community, raise awareness, adapt the project to the context

and use the lessons learnt to improve the approach for replication. For this purpose, the monitoring and evaluation of the intervention, as well as the engagement of the community and the collection and integration of their opinions in the project design is key.

In the following second part of this chapter, examples are provided from the case studies that demonstrate further details which can be taken into account to replicate the respective success.

24.1 Belo Horizonte

It could be assumed that a replication of a certain city's approach in the same country is significantly facilitated, if the respective national policy levels prioritize environmental challenges similarly. Interestingly, the case of Brazil and Belo Horizonte has shown that although prioritized at a local scale, policies do not necessarily have the same relevance at the national level.

Since the mandate of Jair Messias Bolsonaro, environmental policies have experienced a downturn, indicating that the incentives for knowledge transfer and shared learning from the national to the local level are limited. Despite of the twist in environmental politics on a national level, Belo Horizonte shows, nevertheless, that its environmental policies are based on an effective multi-level governance system which enables a bottom-up instead of a top-down approach. As national support has been cut to funding certain urban approaches in Brazil, Belo Horizonte had to identify other financial resources and was able to do so (see Table 32).

Table 38: Factors for successful replication of approaches used in Belo Horizonte

Spotlight: Sustainable urban mobility

Institutional framework	Stakeholder engagement	Financial resources	Pilots
PlanMob-BH in place since 2010 is permanently monitored The technical staff of the implementing agency (BHTrans) was involved in the elaboration of PlanMob-BH. Thus, they are fully committed to achieving its targets and goals Despite the change of priorities in the political agenda from a sustainability to a social inclusion focus, the technical staff was able to continue implementing the measures of PlanMob-BH	PlanMob-BH was elaborated in a participatory process. Civil society groups are still involved and are permanently observing and supporting the adequate implementation of PlanMob-BH. The public acceptance that the active mobility measures implemented have received from the directly impacted community have increased the visibility and popularity of these measures and enable their replication throughout the city. The collaboration of various municipal agencies in the implementation of small active mobility projects has contributed to a cost reduction and an intersectoral approach. Belo Horizonte worked closely with the former Ministry of Cities in the implementation of the PlanMob-BH, mainly through a financial line devoted to the funding of	The lack of financial resources has delayed some of the goals of the plan (e.g.: e-mobility transition). At the same time, BH due to its great work and its involvement in international networks has been able to identify alternative sources for small-scale projects (e.g. Zones 30) from international donors	Using the tools of tactical urbanism, several temporary interventions (Zones 30) have been implemented in the city to showcase the positive impact that Zones 30 could have in the neighbourhood. They are all permanent now and more neighbourhoods have requested the implementation of Zones 30 in their area.

	sustainable mobility measures. Now, however, the restructuring process at the national level has made this cooperation more difficult.		

Source: Own analysis, Wuppertal Institute

24.2 Moscow

Moscow's definition and prioritization of environmental challenges is leaned on the country's national priorities. Moscow's environmental policies are embedded in the national framework, most importantly in two national projects ("Environment" and "Housing and Urban Environment"). As such, the replication of the city's approach can be assumed to be facilitated through top-down policies since a similar prioritization of environmental challenges incentivizes knowledge transfer and facilitates governmental funding from the national to the regional and local level.

On the other hand, the successful replication hinges on a holistic and comprehensive coordination of environmental activities at all involved governmental levels. Many federal and regional environmental strategies are, however, not yet sufficiently connected with each other and lack a cross-sectoral approach. An effective multi-level coordination and communication would have the potential to facilitate the replication of Moscow's environmental policies in cities that combat similar challenges as Russia's capital; but it also enables replicating the identification of environmental problems and the corresponding development of strategies for cities, that face various different challenges, such as cities in the permafrost regions that are particularly affected by the negative consequences of climate change.

Furthermore, as Russia's capital, Moscow's approach in combatting environmental challenges has been successful due to national as well as local funding. Thus, a replication critically depends on the flow of financial and administrative resources to the corresponding cities.

Table 39: Factors for successful replication of approaches used in Moscow

Spotlight: Sustainable mobility

Institutional framework	Stakeholder engagement	Financial resources	Pilots
Legislation on sustainable mobility in Moscow embedded in Russia's Transport Strategy. Moscow's technical staff encourages plans and strategies regarding the promotion of public transport and shared mobility, facilitating the successful implementation of national air quality guidelines and transport strategies in the city.	Sustainable urban mobility is considered a multi-level and cross-sectoral area by the Moscow municipality. Including road safety, public transport, shared mobility services, active mobility and air pollution prevention, public bodies in Moscow are linked to regional and national bodies and coordinate measures based on a holistic and inter-sectorial approach. Enabling public access to air pollution data on a regular level facilitates the visualization of positive impacts of policy measures to mitigate air pollution in Moscow. Public understanding increases legitimization and public support for	As Russia's capital, being the wealthiest city in the country, Moscow has a local pool of financial as well as administrative resources. In addition, it receives federal funding based on the national long-term Transport Strategy.	To decrease congestion, Moscow has set priority amongst others on shared (and active) mobility services. Shared mobility projects can range from small scale projects to city-wide initiatives and are efficient measures to increase public awareness to alternative mobility options.

	environmental measures, such as high parking fees, and encourages the usage of sustainable means of transport.		

Source: Own analysis, Wuppertal Institute

24.3 Kochi

The case study of Kochi has proven that a successful approach in combatting environmental challenges hinges on the effective communication, coordination and development of strategies of interrelated and multi-level governmental institutions. Hence, a replication can be assumed ot be facilitated when the replicating city aligns, similarly to Kochi, top-down policies with bottom-up approaches in terms of supportive roles and responsibilities.

This alignment is based on a strong stakeholder engagement regarding coordination and implementation of policies, knowledge building and sharing, capacity building and innovative ideas between multiple governmental levels.

Table 40: Factors for successful replication of approaches used in Kochi

Spotlight: Air pollution reduction

Institutional framework	Stakeholder engagement	Financial resources	Pilots
Smart Cities Mission, Kochi City Development Plan (CDP), Air Prevention & Control of Pollution Act, Clean Air Action Plan Technical staff of the municipality (in particular of the Kochi Municipal Corporation and the Kochi Metro Rail Limited)) is supported by regional and national governments in terms of policies and implementation of measures. The Central Pollution Control Board (CPCB) provides technical service to MoEFCC. On a regional level, the Centre for Heritage Environment and Development supports knowledge building and sharing, peer-to-peer learning and capacity building. On a local level, the Clean Air Action Plan is developed by different experts, bringing together technical staff from local and international	Aligning top-down policies with bottom-up approaches in a cross-sectoral field requires the inclusion of stakeholders at all policy stages. Multi-level governance regarding air pollution reduction is handled by national, regional as well as local actors in Kochi. The Clean Air Action Plan is, moreover, based on an inclusive strategy for air quality solutions for Kochi. Multiple institutions, involving national, regional and local stakeholders but also research institutes and civil society initiatives engage in the development of a Clean Air Action Plan that serves as a foundation for effective programmes and policies in Kochi Deccan Chronicle, 2017; KMC, 2017).	As one of the 20 selected smart cities, Kochi received substantial funding in the areas of housing, eco-restoration and water management solution (KMC, 2019). Another alternative source for replication cities is the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) which is distributed by the state to 500 selected cities so far (Yedla, 2016).	The Kerala state plans to launch a project to electrify bus service and introduce e-rikshaws into the traffic, as well as handing out taxi permits to only e-rickshaws (Urban Pathways 2018). This policy can serve as a starting point in other cities, including tax incentives for e-vehicle drivers, low-cost programmes for vehicle conversion as well as setting up swapping kiosks at fuel stations.

organizations (Deccan Chronicle, 2017).			

Source: Own analysis, Wuppertal Institute

24.4 Beijing

Beijing has the economic and human resources to identify and combat environmental challenges efficiently; however, other cities may not have a comparable prosperous and geographic conditions; this replication more complicated and may require the provision of additional funding.

Table 41: Factors for successful replication of approaches used in Beijing

Spotlight: Water management

Institutional framework	Stakeholder engagement	Financial resources	Pilots
National framework: Most Stringent Water Resource Management, 13th Five Year Plan (2016-2020), Views of the State Council on Applying the Strictest Water resources Control System Local legislation: Ordinances for Prevention and Control of Water Pollution. A peer-to-peer support system has been established on a regional and a local level for an exchange of knowledge, capacity building and shared learning. For instance, Beijing provided technical and financial assistance to two cities in Hebei Province to control coal-fired boilers (UN Environment 2019).	Water issues are managed via vertical integration as well as horizontal integration (cross-sectoral and cross-regional). For this purpose, the local and regional governance is led by the Leader Group of Water Pollution Control of Beijing and the "Leader Group", respectively. Both institutions implement binding targets that are set on a national level. National targets are first set for provinces; subsequently, they are communicated to subordinate administrative levels and finally they are written into the local officials' annual responsible contract. Regional coordination mechanism are developed for water resource allocation and water ecosystem recovery (Beijing Government, 2016).	Command-and-control instruments (e.g. water consumption quota system) Market-based instruments (e.g. water resource tax reforms, water resource fee system) (GOV, 2018b) Financial incentives: Subsidies for consumers to purchase water-saving appliance; failure of municipalities in committing to national targets, can result in non-approval of new investment projects (Kostka, 2014).	Beijing is s a pilot city itself. As a pilot for both command-and-control as well as market-based instruments to reach national water use efficiency targets, Beijing has proven political willingness to combat water issues.

Source: Own analysis, Wuppertal Institute

24.5 Cape Town

Due to the principle of subsidiarity, South Africa transfers substantial autonomous decision-making from the national to the provincial and local level. In that context, the replication of Cape Town's environmental policies should consider the following elements.

A successful replication s facilitated by an effective cooperation between the different governmental institutions. Based on that, institutions and stakeholders at different governance levels must be given the possibility to profit from a shared vertical as well as horizontal learning process, which facilitates the application of both top-down as well as bottom-up policies at different locations. Finally, Cape Town's success story is a result of available investment flows

and financial resources that facilitate the implementation of ambitious approaches; hence, for replication additional funding is required for cities that do not find themselves in a similar prosperous situation.

Table 42: Factors for successful replication of approaches used in Cape Town

Spotlight: Air pollution reduction

Institutional framework	Stakeholder engagement	Financial resources	Pilots
Several long-term sectoral and cross-sectoral plans and strategies Cape Town has demonstrated political willingness to not only implement national air quality standards, but also to enforce and further develop them. Enforcement is based the City's Air Quality Management Plan, including a penalty system for noncompliance with air quality standards and enforcement power units such as the Air Quality Office and the Air Quality Management Unit.	The principle of minimization at the source as well as the fundamental subsidiarity principle transfers substantial authority to municipalities, which, in cooperation with the provincial and national institutions, enforce and further develop improvement strategies for air quality levels in the city. Monitoring, evaluation, compliance and enforcement of air quality standards critically depend on the cooperation between various institutions: The city's Scientific Services Department, other municipal offices, Air Quality Officer, Air Quality Management Unit. Cape Town's air pollution reduction policy integrates its citizens by informing them on a regular level about urban air pollution and it levels (e.g. Air Quality Booklet), but also by giving them the possibility to actively participate in combatting air pollution, e.g. via district service points and online platforms.	Small scale projects often take place in cooperation with external partners, such as for instance the WWF Trust Bank, Transformative Urban Mobility Initiative and DGMT, the latter providing direct funding for cities (, Cape Town 2020, DGMT 2020). As such, and in case of a lack of resources, projects may depend on external funding.	Open Streets Cape Town is a local and citizen-driven initiative with the aim of changing mobility patterns in the city, including Open Street events, awareness and advocacy campaigns (Cape Town 2020).

Source: Own analysis, Wuppertal Institute

24.6 Jakarta

A clear definition of decision-making authority can be assumed to facilitate the replication of a city's successful environmental policy approach. Despite of Indonesia's strong push towards administrative, political and fiscal decentralization, recent years show a trend back towards the centralization of political powers, creating a complex web of governance. The case study of Jakarta has shown, nevertheless, that the city has been successful in combatting environmental challenges.

Table 43: Factors for successful replication of approaches used in Jakarta

Spotlight: Waste management

Institutional framework	Stakeholder engagement	Financial resources	Pilots

Master Plan for Solid Waste Management in the Capital Special Region of Jakarta in Province Regulation No.3/2013. Integrating the technical staff from the private sector into waste management services has the potential to considerably improve waste collection services, waste transport and treatment in intermediate treatment facilities. The monitorization and measurement of the volume of waste is working efficiently in Jakarta. Other areas need to be improved.	Local standards are subordinate to national jurisdiction. A number of governmental, presidential and ministerial regulations serve therefore as a guidance for local policies. To this end, each administrative area is equipped with local environmental agencies which serve as representatives and communication points with the Province Environmental Department. Community Action Plan programs, including institutions from civil society and science, citizens from Jakarta as well as governmental authorities helped to collaborate such that innovative and sustainable solutions for the city could be found. This includes waste management and sorting, waste utilisation, recycling and controlling disease and hygiene (EP&T & DIM 2017). Public engagement has proven to be highly effective to realize a “Clean Culture Society”. Integrating citizens as key players in waste reduction in the form of waste banks in several districts, helped to reduce waste volume by 35%.	Jakarta has opened up the possibility for private investments in public services (e.g. infrastructure) as well as international funding projects.

Source: Own analysis, Wuppertal Institute

25 Recommendations

Urban environmental protection tackles different challenges - depending on national and local circumstances as well as priorities. Both scientific documents and international political agreements and declarations recognise that there is a whole array of potential and actual challenges which cities (may) have to deal with. These thematic documents cover a wide range of topics, including more traditional aspects, such as land sealing and waste management, but also more recent, cutting edge topics such as resilience and noise pollution. The analysis of the six countries has revealed that traditional challenges remain to be overcome and resolved, whereas new challenges may be on the future radar but are not yet part of city administrations' everyday work.

According to the six case studies, the main challenges are air pollution, climate change and its effects, land sealing/land degradation/desertification, waste management and water management. Those challenges are well known in countries and cities all over the world. Successful approaches to tackle and overcome these problems can be found in the case studies. The preceding chapter has also discussed factors for successful replication of particular approaches (institutional framework, stakeholder engagement, financial resources, pilots).

A recommendation resulting from the study is that the international community should further seek to strengthen the knowledge base and build capacity how to protect the environment at the urban level. The international community can work at multiple scales and build connections across local, regional, national and global actors and policies. The international community can also spark city-to-city and city-to-region connections worldwide. Peer exchange and capacity building about successful approaches to protect the urban environment will lead to imitation and take-off. Cities aim to learn from each other. Therefore, cities should build networks to strengthen such peer exchange.

The UN, multi- and bilateral international cooperation and city networks should build thematic bubbles with cities facing similar challenges. Such initiatives can also guarantee long-term stability of their efforts despite political volatility.

Moreover, cities with similar challenges working in thematic groups can also push for robust policies at the national level that reflect the interests of local and regional governments and apply global policy to sustainable urban development strategies at the subnational level. In general, such strategic alliances of groups of cities with international organizations, national governments, academic and financial institutions, civil society and the private sector creates space for innovation and builds new ways to support sustainable development at the urban scale.

25.1 Patterns of success

The cases which are presented in this study stem from big cities and metropolitan regions. Their ability for proliferation results to a large extent from massive financial and human resources. However, there are other factors of success, and, more importantly, other ways to finance sustainable urban development and capacity building. The study found similar patterns of success factors which could be applied not only to tackle traditional challenges to protect the urban environment, but also new and emerging problems.

Pattern 1: National regulation enforces local responsibility

Environmental protection at the urban level may begin with a certain set of targets, which are defined by the national level, but have to be implemented by the decision makers at the urban

level. Such targets may be technical standards or environmental standards, which leave the process/means to accomplish the targets open to the local level. The study found the following main factors of success, each being illustrated with the help of specific examples of the case studies presented in the previous chapters. They are the result of the analysis of this research and serve as examples for good practices which contribute to the shared learning process in environmental policies at all administrative levels:

a) **The challenge exists country-wide and therefore becomes a political priority to take action at all levels.**

China's environmental governance structure shows how effective top-down policies might be when being combined with a large degree of decision-making autonomy of local authorities. As such, political priorities being formulated at the national level are implemented at the municipal level as well as at the regional level.

b) **Local capacities/resources are available, i.e. technical monitoring equipment and staff in the administration working on the topic.**

The success story of Belo Horizonte shows that strengthening the local administration's capacity facilitates the realization of a specific agenda independently of the political situation in the country. Despite of Brazil's down-turn in environmental policies under President Bolsonaro, the city has been capable of establishing a strong institutional and administrative ground for local environmental policies.

c) **Public pressure through inhabitants' complaints and media coverage.**

Cape Town illustrates the success of the establishment of several local as well as online platforms, that do not only serve as sources for information, accessible for the broad public, but also as centres, where citizens can issue complaints regarding air pollution. The key principle of public participation in the city ensures public acceptance of national and local environmental measures, but also encourages local action against environmental problems.

d) **Enforcement measures.**

The case study of Beijing in China illustrates an effective example of the practical realization of binding targets. Binding targets are not only set at the national level, they are also set for provinces and to subordinate administrative levels. For example, binding targets form part of the respective local officers and form a relevant criterium for their promotion as well as the successful provision of financial investments. Linking national priorities to the local levels and corresponding enforcement measures proves to be highly effective to achieve a successful identification, definition and combat of environmental challenges at all administrative levels.

The case study of Cape Town shows that the inclusion of a penalty system into a city's management plan regarding environmental standards encourages the compliance to local, regional and national targets. In addition, monitoring institutions supervise the compliance of environmental standards

e) **Incentives and awareness raising for the population.**

The case study of Jakarta shows that the integration of citizens in the combat against urban environmental problems leads to desirable outcomes. Measures such as Community Action Plan programs, in which citizens collaborate with NGOs as well as the possibility for citizens to engage actively in environmental campaigns, e.g. supporting a "Clean Culture Society" in the city, support public awareness and public participation.

f) **Noticeable benefits for the city's liveability (quick results).**

Moscow is facing a massive congestion problem on its urban infrastructure with a share private motorization of around 45 percent. The city has, however, implemented an effective measure to reduce the traffic volume on its roads by implementing high parking fees. Compared to other policy measures like the promotion of public transport infrastructure, the implementation of parking fees is measure that is comparatively rapidly implemented and may, therefore, also lead more quickly to desired outcomes.

Pattern 2: Local progress based on national monetary incentives

A common national strategy to foster environmental protection at the local level is to provide monetary support, which is provided based on certain conditions to achieve certain process targets. Such targets may be numbers of devices/equipment used, or a predefined quality level for techniques to be used to protect the environment at the local level. The study found the following main factors of success:

a) **Clear process targets such as benefit to cost ratios or service levels**

Belo Horizonte has developed various urban strategic plans, such as PlanMob BH or BH 2030 Strategic Plan, both being based on clear goals and targets. Encouraging high-quality sustainability measures but also seeking for cost-efficient public spending, the city's approach is based on a clear institutional framework and a sound cooperation between various administrative and technical staff.

b) **Stakeholder commitment**

The case study of Cape Town shows how stakeholder commitment can be encouraged by establishing monitoring institutions to supervise the compliance to environmental standards, such as for example the Air Quality Office and the Air Quality Management Unit. In addition, the city has introduced a penalty system for noncompliance.

Capacity-building programs, peer-to-peer learning and knowledge sharing, as being supported by the Centre for Heritage Environment and Development in Kochi contribute to stakeholders' commitment to local targets.

c) **Monitoring of compliance connected to incentive schemes and fees in case of non-compliance**

Chinas dual mixed governance structure ensures local commitment to national environmental targets by implementing an incentive scheme for local authorities. For example, local stakeholders are only promoted when they were able to achieve binding targets in their administrative areas. In addition, indirect fees in the form of a reduction of investment flows to the corresponding administrative area in case of non-compliance to environmental targets are implemented. The analysis shows that China has a highly effective environmental policy scheme at all governance levels with the enforcement strategies being an important political instrument.

d) **Coherence of other national policies such as fiscal incentives which encourage the same/similar objectives**

The analysis of this report has listed several fiscal incentive schemes that are implemented at different governance levels. At the national level, China has, for instance, introduced a fiscal incentive scheme that neglects local administrative authorities to be promoted in case their policies do not meet binding targets. Moreover, it has implemented a monetary incentive scheme that prevents financial investments if standards are not met. Other examples at the local level, include Moscow which implemented high parking fees and reduced ticketing prices for public transport to reduce the traffic volume on urban roads.

e) **Priorities of the local level need to match with the national level to prevent counterproductive/non-coherent activities at the local level**

South Africa's cooperative governance structure ensures that environmental challenges are tackled at each level of governance. Municipalities but also provincial authorities have considerable decision-making authority to tackle environmental challenges at the root; yet they are required to meet national standards. Coherence in the environmental policies at the different administrative levels is an essential part of South Africa's environmental approach to be successful.

The case of Belo Horizonte is an interesting exception in this context. Although Brazil's environmental policies have experienced a downturn under President Bolsonaro, the city's environmental policies are based on an effective multi-level governance system, enabling a bottom-up approach, being financed by other funding resources than the national funds.

Pattern 3: National directives facilitates local ambition

Local action can be initiated at the national level by setting enabling frameworks. This may include indicative targets and declarations of intent. Such directives usually determine responsibilities for tasks and demand certain legal forms for businesses and partnerships. However, they do not include detailed regulations but leave this to local legislation. The study found the following main factors of success:

a) **National engagement sets examples**

China sets clear standards at the national level that have to be implemented by the provincial and local authorities. It has been shown that China's national engagement has been successful regarding both the identification of challenges as well as the combat against them.

b) **Local capacities, i.e. knowledge/training/experience of staff in the responsible administration**

The case of Belo Horizonte has proven that although national engagement in environmental policies is experiencing a downturn, a stable institutional framework at the local level, based on a sound technical expertise of the administrative staff and active and convincing personalities in the administration, is highly effective with regard to local sustainability measures.

c) **Local incentives and measures in case of non-compliance**

A fiscal and monetary incentive scheme that penalizes non-compliance and awards compliance to national standards, proves to be highly effective in China at all administrative levels.

d) **Existence and development of business cases**

Small scale sustainable Zone 30 projects have been implemented in different districts of Belo Horizonte. Being approved among the local population, their implementation has been dispersed in various parts of the city.

e) **City networks, international support and further encouragement**

The case study of Kochi in India shows that a platform for shared learning, knowledge and capacity building at a local or regional level, increases the effectivity of multi-level governance, and leads to coherent cross-sectoral strategies.

25.2 Recommendations for German cities and institutions

Germany faces other challenges than fast growing megacities in emerging economies. However, the international cases have shown that some basic principles of urban environmental protection proof to be successful:

- The subsidiarity principle
- Sufficient human and financial resources
- Cross-sectoral plans and strategies for the long-term horizon, complemented with sectoral policies and measures
- Comprehensive data, monitoring
- Compliance and enforcement mechanisms
- A mix of command-and-control and market-based policies
- Cooperation of the public sector with civil society

As research and practical experience in Germany is well advanced in a number of fields, German institutions should also contribute to resolving new and emerging urban sustainability challenges worldwide. For instance, noise pollution, walkable green and blue infrastructure, or circular economy are relatively new in many countries, whereas German public institutions can already draw upon experience in such areas.

26 References

Introductory chapters

BMUB (2017): Weißbuch Grün in der Stadt. Berlin: BMUB

Central Intelligence Agency (2016): World Factbook: China. https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html. Aufgerufen am 30.04.2018.

Central Intelligence Agency (2016): World Factbook: India. https://www.cia.gov/library/publications/the-world-factbook/geos/in.html. Aufgerufen am 30.04.2018.

Central Intelligence Agency (n.d.): The World Factbook: Country Comparison. Distribution of Familiy Income. Gini Index. https://www.cia.gov/library/publications/the-world-factbook/rankorder/2172rank.html.

Department of Economic and Social Affairs, United Nations (2015): World Urbanization Prospects: The 2014 Revision. New York.

EU (2007): LEIPZIG CHARTER on Sustainable European Cities. Leipzig: European Union

EU (2020): Renewal of the LEIPZIG CHARTER. Leipzig. European Union

[GIZ] Gesellschaft für Internationale Zusammenarbeit: Mitigating Emissions from Refrigerated Transport. https://www.giz.de/en/worldwide/29177.html.

[GIZ] Gesellschaft für Internationale Zusammenarbeit (2010): Program Transportasi Perkotaan Berkelanjutan - Indonesia/ Sustainable Urban Transport – Programme Indonesia. http://transferproject.org/wp-content/uploads/2015/05/SUTRI_NAMA_Concept-Document_Indonesian-version.pdf

[GIZ] Gesellschaft für Internationale Zusammenarbeit (2021): Promoting sustainable urban transport. https://www.giz.de/en/worldwide/42943.html

[KfW] Kreditanstalt für Wiederaufbau (2017): Emissionen und Städte – Projektinformationen. https://www.kfw-entwicklungsbank.de/PDF/Entwicklungsfinanzierung/Länder-und-Programme/Asien/Projekt-Indonesien-Klima-2015.pdf

UBA (2017a): Die Stadt für Morgen. Umweltschonend mobil – lärmarm – grün – kompakt – durchmischt. Dessau-Roßlau: Umweltbundesamt

UBA (2017b): Urban Mining – Ressourcenschonung im Anthropozän. Dessau-Roßlau: Umweltbundesamt

Umweltbundesamt (2018): Urbaner Umweltschutz. Die strategische Forschungsagenda des Umweltbundesamtes. Dessau-Roßlau: Umweltbundesamt

United Nations (2015): Transforming our world: the 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015 (A/RES/70/1).

United Nations (2016): New Urban Agenda. Resolution adopted by the General Assembly on 23 December 2016 (A/RES/71/256).

United Nations Development Programme: Gender Inequality Index. http://hdr.undp.org/en/composite/GII. Aufgerufen am 30.04.2018.

United Nations Development Programme (2016): Human Development Report 2016: Russian Federation. http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/RUS.pdf. Aufgerufen am 30.04.2018.

United Nations Development Programme (2015): Human Development Index. http://hdr.undp.org/en/indicators/137506#. Aufgerufen am 30.04.2018.

United Nations Development Programme: Human Development Index: Technical Notes. http://hdr.undp.org/sites/default/files/hdr2016_technical_notes_0.pdf. Aufgerufen am 30.04.2018.

United Nations World Urbanization Prospects (2018): https://population.un.org/wup/.

[UNECE] United Nations Economic Commission for Europe (n.d.): Air pollution and food production. https://www.unece.org/environmental-policy/conventions/envlrtapwelcome/cross-sectoral-linkages/air-pollution-and-food-production.html

WBGU (2016): Der Umzug der Menschheit: Die transformative Kraft der Städte. Berlin: WBGU

WorldBank: Poverty Headcount Ratio. https://data.worldbank.org/indicator/SI.POV.DDAY?view=chart. Aufgerufen am 30.04.2018.

WorldBank (2019): Urban Population (% of total). https://databank.worldbank.org/reports.aspx?source=2&series=SP.URB.TOTL.IN.ZS&country=#. Aufgerufen am 27.11.2020.

Brazil

ABC Biodiversidad. (2019, January 4). El nuevo Código Forestal de Brasil abre la puerta a la deforestación legal en la Amazonia. ABC. https://www.abc.es/natural/biodiversidad/abci-nuevo-codigo-forestal-brasil-abre-puerta-deforestacion-legal-amazonia-201901041149_noticia.html

Abrelpe. (2019, November 27). O Descaminhos do Lixo – Abrelpe [Institutional]. Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais (Abrelpe). http://abrelpe.org.br/brasil-produz-mais-lixo-mas-nao-avanca-em-coleta-seletiva/

AirVisual. (2019). 2018 World Air Quality Report. Region & City PM2.5 Ranking (V1.1). IQAir. https://www.airvisual.com/world-most-polluted-cities/world-air-quality-report-2018-en.pdf

Alfaira, R.G.S.M., Costa, A.M. and Campos, J.C. (2017): Municipal Solit Waste in Brazil: A Review. In: Waste Management Res.35(12), pp. 1195-1209.

Allison, E. (2017): Costa do Brasil é vulnerável a mudanças climáticas, diz relatório. In: Exame, June 05, 2017. https://exame.abril.com.br/ciencia/nivel-do-mar-na-costa-brasileira-tende-a-aumentar-em-decadas/.

Almeida, M. (2012): Analysing the Brazilian Sugarcane Agroecological Zoning: Is this Government Policy Capable of Avoiding Adverse Effects form Land-Use Change? http://researcharchive.vuw.ac.nz/xmlui/bitstream/handle/10063/2418/thesis.pdf?sequence=1

American National Standard Institute (n.d.): Brazilian Government Entities. https://www.standardsportal.org/Brazil/re sources/Brazilian-Government-Entities.aspx.

Arioli, M.; Kodukula, S.; Shrestha, S. and Werland, S. (2018): Brazil Summary.https://www.urban-pathways.org/uploads/4/8/9/5/48950199/up_brazil-summary.pdf.

Assuncao, J., and Chiavari, J. (n.d.): Towards Efficient Land Use in Brazil. In: The New Climate Economy, the Global Commision on the Economy and Climate. https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/Towards-Efficient-Land-Use-Brazil.pdf.

Aubertin, C. (2015): Deforestation Control Policies in Brazil: Sovereignty Versus the Market. https://www-tandfonline-com.proxy-ub.rug.nl/doi/pdf/10.1080/14728028.2015.1017540?needAccess=true.

Bast, E. (2018, September 14). Brasil tem quase 3 mil lixões em 1.600 cidades, diz relatório [Newspaper]. G1 - globo.com.https://g1.globo.com/natureza/noticia/2018/09/14/brasil-tem-quase-3-mil-lixoes-em-1600-cidades-diz-relatorio.ghtml

Bello, Luiz (2018): Dia Nacional da Habitação: Brasil tem 11,4 Milhões de Pessoas Vivendo em Favelas. Agencia IBGE Noticias, February, 01, 2018. https://agenciadenoticias.ibge.gov.br/2012-agencia-de-noticias/noticias/15700-dados-do- censo-2010-mostram-11-4-milhoes-de-pessoas-vivendo-em-favelas.html.

[BERST] Bioeconomy Regional Strategy Toolkit (n.d.): Factsheet: NWRMS and NWRP. https://berst.vito.be/node/2142.

[CAIT] Climate Data Explorer (2014): Brazil. Country GHG Emissions. http://cait.wri.org/profile/Brazil.

Câmara dos Deputados. (2019, May 22). Plenário mantém fusão dos ministérios das Cidades e da Integração Nacional - Notícias [Institutional]. Portal da Câmara dos Deputados. https://www.camara.leg.br/noticias/558203-plenario-mantem-fusao-dos-ministerios-das-cidades-e-da-integracao-nacional/

[CAT] Climate Action Tracker (2018): Brazil. https://climateactiontracker.org/countries/brazil/.

[CCAFS] Climate Change, Agriculture and Food Security (n.d.): Brazil´s Low-Carbon Agriculture (ABC) Plan. https://csa.guide/csa/brazil-s-low-carbon-agriculture-abc-plan.

Climate Regulation Brazil (2017). Accessed 22.06.2018. https://gettingthedealthrough.com/area/42/jurisdiction/6/climate-regulation-brazil/.

CONAMA Resolution 5/89 (1989): National Program for the Control of Air Pollution. August 25, 1989. http://www.braziliannr.com/brazilian-environmental-legislation/conama-resolution-5-89/.

Congresso Em Foco. (2019, August 9). Brasil é pioneiro no monitoramento da cobertura vegetal Amazônica. Congresso em Foco. https://congressoemfoco.uol.com.br/meio-ambiente/brasil-e-pioneiro-no-monitoramento-da-cobertura-vegetal-amazonica/

Cordeiro, E. A. F. (2019, June 6). MMA anuncia programa de qualidade do ar [Institutional]. Ministério do Meio Ambiente (MMA). https://www.mma.gov.br/informma/item/15508-mma-anuncia-programa-de-qualidade-do-ar.html

Costa, A.F., Hoek, G., Brunekreef, B. and Ponce de Leon, A.C.M. (2017): Air pollution and deaths among elderly residents of Sao Paulo. Brazil: An analysis of mortality displacement. Environmental Health Perspectives, 125(3), pp.349-354,https://ehp.niehs.nih.gov/doi/full/10.1289/EHP98.

Dallagnol, A.; Silva, M. and Overbeek, W. (2016): The Brazilian Biodiversity Law: Progress or Threat? https://wrm.org.uy/articles-from-the-wrm-bulletin/section1/the-brazilian-biodiversity-law-progress-or-threat/.

Delpupo, M.W., and Bueno, J.G.R. (2015): Constitution and the Fundamental Right to Sanitation. In: International Journal of Law and Political Sciences, 9(7). https://waset.org/publications/10002289/brazilian-constitution-and-the-fundamental-right-to-sanitation.

Domingues, F. (2019, May 29). Entenda o debate sobre a MP 867, que altera o Código Florestal. G1. https://g1.globo.com/natureza/noticia/2019/05/29/entenda-o-debate-sobre-a-mp-867-que-altera-o-codigo-florestal.ghtml

Domtotal. (2019, April 6). Código Florestal: MP 867 que perdoa crimes ambientais perde validade, mas Bolsonaro promete novo texto. domtotal. https://domtotal.com/noticia/1361854/2019/06/codigo-florestal-mp-867-que-perdoa-crimes-ambientais-perde-validade-mas-bolsonaro-promete-novo-texto/

Esparta, A.R.J. (2016): Technical Assistance to the Low Carbon Business Action in Brazil. In: Service Contract for European Union External Axtions. http://www.lowcarbonbrazil.com/_site//doc/LCAB-publications/LCBA_Mapping%20Report_Part%201_White%20Paper_final.pdf.

Farias, V. (2019a, November 6). Bolsonaro revoga decreto que impedia cana-de-açúcar na amazônia. Congresso em Foco. https://congressoemfoco.elav.tmp.br/meio-ambiente/bolsonaro-revoga-decreto-e-permite-cana-de-acucar-na-amazonia/

Farias, V. (2019b, November 18). Desmatamento na Amazônia cresce 30% em um ano. Congresso em Foco. https://congressoemfoco.uol.com.br/meio-ambiente/desmatamento-na-amazonia-cresce-30-em-um-ano/

Fearnside, P. (2017): Deforestation of the Brazilian Amazon.http://environmentalscience.oxfordre.com/view/10.1093/acrefore/9780199389414.001.0001/acrefore-9780199389414-e-102.

Federal Government of Brazil, [IPEA] Institute for Applied Economic Research and [MP] Conseho das Cidades (2016): Federative Republic of Brazil National Report for Habitat III. http://repositorio.ipea.gov.br/bitstream/11058/6269/1/Federative% 20republic%20of%20Brazil%20national%20report%20for%20Habitat%20III.pdf.

Federative Republic of Brazil (n.d.): Intended Nationally Determined Contribution: Towards Achieving the Objective of the United Nations Framework Convention on Climate Change. http://www4.unfccc.int/submissions/INDC/Pubiished%20Documents/Brazil/1/BRAZIL%20iNDC%20english%20FINAL.pdf.

Federal Government of Brazil, National Secretary of Environmental Sanitation and Ministry of Cities (2010). Brazilian Basic Sanitation Policy and Human Rights. http://www2.ohchr.org/english/issues/water/Iexpert/docs/StateActors/ BrazilLaw_11445%20Geneva.pdf.

Fernandes, G.W. et al. (2017): Dismantling Brazil´s Science Threatens Global Biodiversity Heritage. In: Perspectives in Ecology and Conservation, 2017, pp.1-5. http://www.crbio04.gov.br/images/artigo_gwilsonetal.pdf.

Figueiredo, D. (2019, October 3). Ministério do Meio Ambiente em 2019: retrospectiva do primeiro semestre. Politize! https://www.politize.com.br/ministerio-do-meio-ambiente-em-2019/

Flexor, G. and Kato, K. (2016): Biofuels and Inclusive Development: The Brazilian Experience. In: Development in Practice 27(2), pp. 157-167. https://www.tandfonline.com/doi/full/10.1080/09614524.2017.1284763.

Flueckiger, L. (2015): Waste Production in Brazil Grew 29 Percent in 11 Years. In: The Rio Times, July 28, 2015.http://riotimesonline.com/brazil-news/rio-business/waste-production-in-brazil-grew-29-percent-in-11-years/.

Francoso, R.D., Brandao, R., Nogueira, C.C., Salmona, Y.B., Machado, R.B. and Colli, G.R. (2015): Habitat Loss and the Effectiveness of Protected Areas in the Cerrado Biodiversity Hotspot. In: Natureza & Conservação, 13(1), pp.35-40.

Garcia, G. (2019, August 20). Vinte e um fatos que comprovam o desmonte da política ambiental. Congresso em Foco. https://congressoemfoco.uol.com.br/meio-ambiente/vinte-e-um-fatos-que-comprovam-o-desmonte-da-politica-ambiental/

Gebara, M.F., and Thuault, A. (2013): GHG Mitigation in Brazil´s Land Use Sector: An Introduction tot he Current National Policy Landscape. http://www.wri.org/sites/default/files/ghg-mitigation-brazil-land-use-sector.pdf.

Global Forst Watch (2020). Brazil Statistics and Deforestation Rates. https://www.globalforestwatch.org/.

Gortázar, N. G. (2019, July 29). El Brasil de Bolsonaro, villano ambiental planetario. El País. https://elpais.com/internacional/2019/07/28/actualidad/1564267856_295777.html

IEA Clean Coal Centre (2016): Emission Standards: Brazil.https://www.iea-coal.org/wp-content/uploads/2017/12/Brazil-emissions-standard-1.pdf.

IHU. (2016, May 13). OMS: 80% da população urbana mundial vive sob níveis nocivos de poluição. Instituto Humanitas Unisinos (IHU). http://www.ihu.unisinos.br/noticias/555029

Ioris, A.A.R. (2008): Water Reforms in Brazil: Opportunities and Constraints. https://www.tandfonline.com/doi/abs/10.1080/09640560903083756?journalCode=cjep20.

ISA. (2019, September 1). O que muda (ou sobra) no Meio Ambiente com a reforma de Bolsonaro? Instituto Socioambiental (ISA). https://www.socioambiental.org/pt-br/noticias-socioambientais/o-que-muda-ou-resta-no-meio-ambiente-com-a-reforma-de-bolsonaro

Krug, T., Ometto, J., Aragão, L., & Vinhas, L. (2019). O Brasil e as Mudanças Climáticas (p. 9). Instituto Nacional de Pesquisas Espaciais (INPE). http://www.inpe.br/noticias/arquivos/pdf/brasil-e-as-mudancas-climaticas.pdf

Lacey, S. (2018): Water Pollution in Brazil a Serious Issue with some Improvements. https://borgenproject.org/water-pollution-in-brazil/.

Libanio, P.A.C. (2017): Two Decades of Brazil´s Participatory Model for Water Resources Management: From Enthousiasm to Frustration. In: Journal Water International, 43(4), pp.494-511.

Maisonnave, F. (2017): Brazil´s Carbon Emissions Rose 8.9% in 2016, Despite Recession.http://www.climatechangenews.com/2017/10/27/brazils-carbon-emissions-rose-8-9-2016-despite-recession/.

Matos de Oliveira, A. L. (2019, October 31). Brasil tem 28 milhões de carros e 13 milhões de motos a mais. Fundação Perseu Abramo. https://fpabramo.org.br/2019/10/31/brasil-tem-28-milhoes-de-carros-e-13-milhoes-de-motos-a-mais/

Miles, T. (2018, March 5). These are the world's most polluted cities. World Economic Forum. https://www.weforum.org/agenda/2018/05/these-are-the-worlds-most-polluted-cities/

Ministério de Minas e Energia (2017): Plano Decenal de Expansao de Energia 2026.http://www.mme.gov.br/documents/10584/0/PDE2026_versao_para_publicacao_08dez2017.pdf/f5d8f999-566d-4f5b-9167-d80b6ea8924e.

Ministério da Saúde. (2019). Saúde Brasil 2018. Uma análise da situação de saúde e das doenças e agravos crônicos: desafios e perspectivas. Ministério de Saúde. Secretaria de Vigilância em Saúde. Departamento de Vigilância de Doenças e Agravos Não Transmissíveis e Promoção da Saúde.http://bvsms.saude.gov.br/bvs/publicacoes/saude_brasil_2018_analise_situacao_saude_doencas_agravos_cronicos_desafios_perspectivas.pdf

[MMA] Ministry of Environment of Brazil (2010): New Decree Details Brazil´s National Policy on Climate Change.http://www.mma.gov.br/informma/item/6793-new-decree-details-brazils-national-policy-on-climate-change.

[MMA] Ministry of Environment of Brazil (2011): Strategies to Reduce Deforestation in Brazil: From Controlling Illegal Deforestation to the Challenge of Sustainable Production in the Country´s Forests and Savannas.http://www.stapgef.org/sites/default/files/stap/wp-content/uploads/2013/09/Strategies-to-Reduce-Deforestation-in-Brazil.pdf.

[MMA] Ministry of Environment and Secretariat of Biodiversity Brazil (2016): National Biodiversity Strategy and Action Plan. https://www.cbd.int/doc/world/br/br-nbsap-v3-en.pdf.

[MMA] Ministry of Environment of Brazil (2019a). Agenda Nacional de Qualidade Ambiental Urbana [Institutional]. Ministério do Meio Ambiente. https://www.mma.gov.br/agenda-ambiental-urbana.html

[MMA] Ministry of Environment of Brazil (2019b). Plano de Combate ao Lixo no Mar (No. 1; Agenda Nacional de Qualidade Ambiental Urbana). Ministério do Meio Ambiente (MMA), Secretaria de Qualidade Ambiental, Departamento de Gestão Ambiental Territorial, Coordenação-Geral de Gerenciamento Costeiro. https://www.mma.gov.br/images/agenda_ambiental/lixo-no-mar/Plano-Nacional-de-Combate-ao-Lixo-no-Mar-27.03-FINAL.pdf

[MMA] Ministry of Environment of Brazil (2019c). Programa Nacional Lixão Zero (No. 2; Agenda Nacional de Qualidade Ambiental Urbana). Ministério do Meio Ambiente (MMA), Secretaria de Qualidade Ambiental,

Departamento de Qualidade Ambiental e Gestão de Resíduos, Coordenação-Geral de Qualidade Ambiental e Gestão de Resíduos.
https://www.mma.gov.br/images/agenda_ambiental/residuos/programalixaozero_saibamais.pdf

Nachmany, M. et al. (2015): The 2015 Global Climate Legislation Studdy. A Review of Climate Change Legislation in 99 Countries. In: Grentham Research Institut on Climate Change and the Environment, GLOBE and Inter-Parliamentary Union. http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2015/05/BRAZIL.pdf.

Neves, E.M.S.C. (2016): Institutions and Environmental Governance in Brazil: The Local Governments´ Perspective. In: Revista de Economia Contemporanea 20(3).

Observatório do Clima (2017): The Road from Paris: Brazil´s Progress Toward its Climate Pledge. https://www.nrdc.org/sites/default/files/paris-climate-agreement-progress-2017-brazil-ib.pdf.

Ochoa-Quintero, J.M. (2015): Amazon Deforestation 'Threshold' Causes Species Loss to Accelerate. University of Cambridge. http://www.cam.ac.uk/research/news/amazon-deforestation-threshold-causes-species-loss-to-accelerate.

[OECD] Organisation for Economic Co-operation and Development (n.d.). Brazil. Federal Country. https://www.oecd.org/regional/regional-policy/profile-Brazil.pdf.

Osava, M. (2006): Environment-Brazil: Eye on Urban Water Pollution. http://www.ipsnews.net/2006/10/environment-brazil-eye-on-urban-water-pollution/.

Pina, R. (2019, May 3). Bolsonaro corta 95% do orçamento das ações destinadas a combater mudanças climáticas. Brasil de Fato. https://www.brasildefato.com.br/2019/05/03/bolsonaro-corta-95-do-orcamento-das-acoes-destinadas-a-combater-mudancas-climaticas/index.html

[PPCDAm] Action Plan for Deforestation Prevention and Control in the Legal Amazon. http://www.climatepolicydatabase.org/index.php/Action_Plan_for_Deforestation_Prevention_and_Control_in_the_Legal_Amazon_(PPCDAm).

[PRONAR] Programa Nacional de Controle de Qualidade do Ar (1989).http://www.mma.gov.br/estruturas/163/_arquivos/pronar_163.pdf

Ramos, M. (2019, January 10). Qual a função do Ibama, órgão que multou Bolsonaro e é criticado pelo presidente. Brasil de Fato. https://www.brasildefato.com.br/2019/01/10/qual-a-funcao-do-ibama-orgao-que-multou-bolsonaro-e-e-criticado-pelo-presidente/index.html

Ribeiro de Carvalho, C. H. (2011). EMISSÕES RELATIVAS DE POLUENTES DO TRANSPORTE URBANO (Boletim regional, urbano e ambiental). Instituto de Pesquisa Econômica Aplicada (IPEA). http://repositorio.ipea.gov.br/bitstream/11058/5574/1/BRU_n05_emissões.pdf

Romano, O., Gammeltoft, P. (n.d.): Governance of Drinking Water and Sanitation Infrastructure in Brazil. http://www3.ana.gov.br/portal/ANA/todos-os-documentos-do-portal/documentos-sas/arquivos-cobranca/documentos-relacionados-saneamento/governance-of-ws-infrastructure-in-brazil_final.pdf.

[Secom] Secretariat for Social Communication of the Presideny of Brazil (2012): Biodiversity in Brazil. Fact Sheet.http://static1.squarespace.com/static/559484e4e4b0359276bd82c0/55aba209e4b02272b0068ddf/55aba20be4b02272b0068ef6/1352141364000/Fact-sheet_india_final.pdf?format=original.

Semenário (2018). Qualidade do ar nas Cidades Braisleiras é discutida Pelo Conama (2018). Semenário.com, February, 01, 2018. http://www.semanario.com.br/noticia/2018/02/qualidade-do-ar-nas-cidades-brasileiras-e-discutida-pelo-conama/23787.

Schelp, D. (2019, August 22). Salles quer criar força-tarefa com mineradoras e ONGs para a Amazônia. Folha de S.Paulo. https://www1.folha.uol.com.br/ambiente/2019/08/salles-quer-criar-forca-tarefa-com-mineradoras-e-ongs-para-a-amazonia.shtml

SEEG - Monitor Elétrico. (2018). PARTICIPAÇÃO DAS FONTES NA GERAÇÃO DE ELETRICIDADE. Sistema de Estimativas de Emissões de Gases de Efeito Estufa (SEEG) - Monitor Elétrico. http://monitoreletrico.seeg.eco.br/

The Worldbank Group (2010): Green Cities: Cities and Climate Change in Brazil. https://openknowledge.worldbank.org/bitstream/handle/10986/12785/701860ESW0P1180ate0Change0in0Brazil.pdf?sequence=1&isAllowed=y.

TransportPolicy (2018): Brazil: Air Quality Standards. Accessed 22.06.2018. https://www.transportpolicy.net/standard/brazil-air-quality-standards/.

Trigueiro, A. (2019, March 6). 15 pontos para entender os rumos da desastrosa política ambiental no governo Bolsonaro. G1 - globo.com. https://g1.globo.com/natureza/blog/andre-trigueiro/post/2019/06/03/15-pontos-para-entender-os-rumos-da-desastrosa-politica-ambiental-no-governo-bolsonaro.ghtml

Trisotto, F. (2019, July 18). O 'roubo' em Noronha e mais 5 polêmicas do governo Bolsonaro na área ambiental [Newspaper]. Gazeta do Povo. https://www.gazetadopovo.com.br/republica/polemicas-governo-jair-bolsonaro-ricardo-salles-meio-ambiente/

Tuffani, M. (2019, September 1). Veja 10 ações do governo Bolsonaro no desmonte da política ambiental [Newspaper]. Folha de S.Paulo. https://www1.folha.uol.com.br/ilustrissima/2019/09/veja-10-acoes-do-governo-bolsonaro-no-desmonte-da-politica-ambiental.shtml

[UNEP, WCMC] United Nations Environmental Programme and World Conservation Monitoring Centre (2009): The impacts of biofuel production on biodiversity: A review of the current literature. https://www.cbd.int/agriculture/2011-121/UNEP-WCMC3-sep11-en.pdf.

[UNESCO] United Nations Educational, Scientific and Cultural Organization (n.d.): Biodiversity in Brazil. http://www.unesco.org/new/en/brasilia/natural-sciences/environment/biodiversity/

Tischer, V., Fountas, G., Polette, M. and Rye, T. (2019): Environmental and economic assessment of traffic-related air pollution using aggregate spatial information: A case study of Balneário Camboriú, Brazil. Journal of Transport & Health 14,https://doi.org/10.1016/j.jth.2019.100592.

Waste Expo Brazil (2018): Brazil Recycled 280,000 Tons of Aluminium Cans in 2016 and the Environment is Grateful. http://www.wasteexpo.com.br/organizacaoeng-copiar.html.

[WHO] World Health Organization (2018): WHO Ambient Air Pollution City Database.http://www.who.int/airpollution/data/cities/en/.

[WHO] World Health Organization (2020): Non-communicable diseases. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases.

World Bank (2016). Agricultural land (% of total land) – Brazil. https://data.worldbank.org/indicator/AG.LND.AGRI.ZS?locations=BR.

[WRI] World Research Institute (2017): Relatório Analisa a Implementacao da Política Climática Brasileira.http://wribrasil.org.br/pt/blog/2017/10/relatorio-analisa-implementacao-politica-climatica-brasileira.

[WWF] World Wide Fund for Nature (n.d.): Deforestation. Overview. https://www.worldwildlife.org/threats/deforestation.

Yeo, S. (2015, September 29). Analysis: Brazil's climate pledge represents slight increase on current emissions. Carbon Brief. https://www.carbonbrief.org/analysis-brazils-climate-pledge-represents-slight-increase-on-current-emissions

Russia

Air, water and noise pollution

Accounts Chamber (2020): Report on the results of the expert-analytical event "Monitoring the implementation of the activeties of the national project" Ecology ", including the timeliness of their financial support, achievement of goals and objectives, milestones, as well as the quality of management", January 2020 http://audit.gov.ru/activities/control/%D0%AD%D0%BA%D0%BE%D0%BB%D0%BE%D0%B3%D0%B8%D1%8F%202020-01-15%20[1].pdf.

Autostat (2018): (statistics of Euro standards at the Russian car market and of electric cars penetration to the Russian market) https://www.autostat.ru/.

Bakunovich, P. (2018): Russia introduces project Ecology. https://www.climatescorecard.org/.

B. A. Revich, S. L. Avaliani, G. J. Simons, Air pollution and public health in a megalopolis: a case study of Moscow, Economy of the Region, 4/2016 http://www.economyofregion.com/archive/2016/63/2878/

Best Available Technologies Office (statistics and reference books for the BAT), http://burondt.ru/.

FAO (2017): Water Database. http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en.

Finmarket.ru, (2019): Moscow may restrict the entry of vehicles of low environmental classes,http://www.finmarket.ru/news/4931432.

Institute of Lake Science of the Russian Academy of Sciences and the Russian State Hydrometeorological University (2019): Widespread microplastic pollution was discovered by scientists on the beaches and ponds of the North-West, Interfax news agency, 10.01.2019 https://academia.interfax.ru/ru/news/articles/2258.

Kommersant (2020): Energy efficiency policy still fails for Russian authorities. https://www.kommersant.ru/doc/4220313?.

Legislation on the Best available technologies (Amendment to the Federal Law „On environmental protection“ http://www.consultant.ru/document/cons_doc_LAW_34823/5b5677b304ec83610cb849eb108fadf413b1ea5a/

Moscow City Government Department for Nature Use and Environmental Protection (2017): Noise pollution in Moscow.http://www.dpioos.ru/eco/ru/noise.

Moscow Department of Transport (2019): Sergei Sobyanin spoke about a new stage in the development of car sharing - now electric cars, 30.09.2019. https://www.mos.ru/mayor/themes/2299/5986050/

National project "Ecology" (2018):http://static.government.ru/media/files/7jHqkjTiGwAqKSgZP2LosFTpKo66kEu2.pdf.

On amendments to the technical regulation of the Customs Union "On the safety of wheeled vehicles", 21.06.2019.

[PWC] Pricewaterhousecoopers (2019: In two or three years, Moscow car sharing will be closed to new players. https://vc.ru/pwc/73168-carsharing.

RBC (2019): Experts have predicted an increase in sales of electric vehicles in Russia to 30% per year,. https://www.rbc.ru/society/26/09/2019/5d8b7f779a7947ef60486b26.

Report „Ecological priorities for Russia: human development in the Russian Federation“, Analytical Centre of the Government of Russia, 2017 http://ac.gov.ru/files/publication/a/15600.pdf

Report „On ecological development of the Russian Federation in the interests of future generations” (December, 2016) http://ecoline.ru/wp-content/uploads/report-on-the-ecological-development-of-the-russian-federation-in-the-interests-of-future-generations-2016.pdf.

Report „On the state and management of environment in Russian Federation in 2016“ http://mnr.gov.ru/docs/o_sostoyanii_i_ob_okhrane_okruzhayushchey_sredy_rossiyskoy_federatsii/gosudarstvennyy_doklad_o_sostoyanii_i_ob_okhrane_okruzhayushchey_sredy_rossiyskoy_federatsii_v_2016_/

Report “On the state of environment in the city of Moscow in 2017” http://www.dpioos.ru/eco/ru/report_result/o_448938

Roshydromet Climate Center. Report on the climate risks in the Russian Federation. (2017)

Russian Ecological Society (2019): The results of the opinion poll in the framework of the national project "Ecology", December 2019 http://ecosociety.ru/bez-rubriki/rossijskoe-ekologicheskoe-obshhestvo-podvelo-itogi-sotsiologicheskogo-oprosa-po-natsproektu-ekologiya/

Russian Public Opinion Research Center (2019): A poll about attitudes of Russians towards environemtal issues, February, 2019 https://wciom.ru/index.php?id=238&uid=9548 .

SDGs and Russia: Human development index, Analytical Centre of the Government of Russia, 2016 http://ac.gov.ru/files/pub lication/a/11138.pdf

Shaposhnikov, D., Revich, B., Bellander, T., Bedada, G.B., Bottai, M., Kharkova, T., Kvasha, E., Lezina, E., Lind, T., Semutnikova, E. and Pershagen, G. (2014): Mortality Related to Air Pollution with the Moscow Heat Wave and Wildfire of 2010, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3984022/

Succow Stiftung (n.d.): Restoring peatlands in Russia. Preventing peat fires, mitigating climate change. https://succow-stiftung.de/tl_files/pdfs_downloads/Projektinfos/WI-Leaflet_A4_Peatlands_web.pdf.

WWF (n.d.). Adaptation to Climate Change. https://new.wwf.ru/what-we-do/climate-and-energy/adaptation-to-climate-change/

Kleyn S.V.* Zaitseva N.V. Andrishunas A.M. Vekovshinina S.A. Nikiforova N.V. (2020): Dynamic analysis of atmospheric air quality and its impact on public health. In: Advances in Health Sciences Research. 28. International Conference on “Health and Wellbeing in Modern Society”.

Climate change and its effects

Accounts Chamber (2020): Report on the results of the expert-analytical event "Monitoring the implementation of the activeties of the national project" Ecology ", including the timeliness of their financial support, achievement of goals and objectives, milestones, as well as the quality of management", January 2020 http://audit.gov.ru/activities/control/%D0%AD%D0%BA%D0%BE%D0%BB%D0%BE%D0%B3%D0%B8%D1%8F%202020-01-15%20[1].pdf.

Akimov V., Durnev R., Sokolov Yu.. Protection of the population and territories of the Russian Federation in a changing climate. 2016

Analytical Center for the Government of the Russian Federation. 2017. http://ac.gov.ru/events/014140.html

Annual state report on the conservation and efficiency of energy consumption in the Russian Federation (2019) http://economy.gov.ru/material/news/opublikovan_gosdoklad_po_energoeffektivnosti.html.

[CAT] Climate Action Tracker (2020): Russian Federation. Country Summary. https://climateactiontracker.org/countries/russian-federation/.

Davydova, A. (2019): In the shadow of strict protest laws, young Russians build a climate movement, Reuters, 27.09.2019 https://www.reuters.com/article/us-russia-climate-change-activists/in-the-shadow-of-strict-protest-laws-young-russians-build-a-climate-movement-idUSKBN1WC18N.

European Environment Agency (2016): Urban adaptation to climate change in Europe - Transforming cities in a changing climate.

Fedorov Yu. Measures to reduce greenhouse gas emissions implemented by the government of the Russian Federation. 2017. http://eic-ano.ru/publications/presentations/getfile.php?file=FedorovUN_24052017_pdf

Gasho E., Guseva T., Stepanova M., Malkov A., Lomakina I. Developing climate change strategy for Moscow. In: Proceedings of SGEM Vienna GREEN 2017. Vienna, 2017. Vol. 17. Issue 43. pp. 357-364

Government of the Russian Federation (2016): implementation plan for improvement of government regulation of emissions greenhouse gases and for preparation of ratification of the Paris Agreement . http://gov.garant.ru/SESSION/PILOT/main.htm.

Government of the Russian Federation (2020): National action plan for the first phase of adaptation to climate change until 2022, January 2020 http://government.ru/docs/38739/.

INDC Russia (2015): INDC Submission Russia. https://www4.unfccc.int/sites/submissions/INDC/Submission%20Pages/submissions.aspx.

INEI, Analytical Center for the Government of the Russian Federation. Forecast for the development of the energy sector in Russia and the world. 2014. 167 p. https://www.eriras.ru/files/forecast_2040.pdf

[IRENA] International Renewable Energy Agency (2017): Remap 2030. Renwable Energy Prospects for the Russian Federation. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Apr/IRENA_REmap_Russia_paper_2017.pdf

Kattsov V., Porfiryev B.. Climate change adaptation for Russia: a concept of the national plan. // Proceedings of the VoeikovMain Geophysical Observatory. 2017. No. 586, pp. 7-20 (in Russian)

Kobylkin D. 2010. https://ria.ru/arctic_news/20101125/300725337.html

Kokorin A. Analysis of Problem of the Skeptical View on the Anthropogenic Reasons of Climate Change. Natural Resources Conservation Journal. 2017, No. 4 (152), pp. 105–110.

Kommersant (2020): Energy efficiency policy still fails for Russian authorities. https://www.kommersant.ru/doc/4220313?.

Makarov I. Greenhouse gas emissions reduction and energy efficiency of the Russian economy. Sustainable Development Bulletin. 2014, no. 68, pp. 19-26

Malinin V., Menzhulin G., Pavlovskii A. Town-Planning Of St. Petersburg in the Conditions Of Modern Climate Changes // Proceedings of the Russian State Hydrometeorological University. 2016. No. 43, pp. 140-147

Meredith, E. P., Semenov, V. A., Maraun, D., Park, W., & Chernokulsky, A. V. (2015). Crucial role of Black Sea warming in amplifying the 2012 Krymsk precipitation extreme. Nature Geoscience, 8(8), 615.

Ministry of Energy of the Russian Federation (Minenergo). 2018. https://minenergo.gov.ru/node/10356

Molchanova Ya., Guseva T., Malkov A., Konovalova Yu., Begak M. Climate change adaptation in planning: using the European experience for Moscow // Proceedings of the Dmitry Mendeleev University of Chemical Technology of Russia. 2017. No. 8, pp. 163-171.

Moscow Department of Environment and Nature Use (2019): Moscow in five years reduced greenhouse gas emissions by18%. RIA Novosti. https://ria.ru/20190402/1552312365.html.

Mosgorstat. Estimates of Moscow population for 2018. http://moscow.gks.ru/wps/wcm/connect/rosstat_ts/moscow/ru/statistics/population/

Plus One. 20.11.2017 https://plus-one.ru/blog/ecology/samostoyatelnaya-adaptaciya-gorodov (in Russian)

Poberezhskaya M. Media coverage of climate change in Russia: Governmental bias and climate silence. Public Understanding of Science, 2014, Vol 24, Issue 1, pp. 96 - 111

Putin V. at the Presentation of foreign ambassadors' letters of credence. 2018: http://en.kremlin.ru/events/president/news/57238

Rahmstorf S., Coumou D. Increase of extreme events in a warming world. Proceedings of the National Academy of Sciences Nov 2011, 108 (44) 17905-17909; DOI: 10.1073/pnas.1101766108

Revich B. Heat waves, air quality and mortality in European Russia in summer 2010: a preliminary assessment // Human Ecology. 2011. No. 7, pp. 3-9

Revich B., Shaposhnikov D. Heatwaves and cold waves and mortality in the Arctic cities // Working papers of the Fundamental Sciences for Medicine program, 2010. pp. 225–226.

Revich B., Shaposhnikov D., Podolnaya M., Kharkova T., Kvasha E. Heatwaves in the southern Russian cities as a risk factor for premature deaths // Problems of Prognosis. 2015. No. 2, pp. 56-67

Revich B., Shartova N., Konstantinov P. Ecological and climatic specificities of some Russian megacities. Environmental Issues of Industrial Cities. 2017. pp. 71-74.

RIA Novosti (2019): Scientists estimate CO2 emissions from forest fires in Siberia, RIA Novosti, 08.08.2019 https://ria.ru/20190808/1557292850.html.

Roshydromet Climate Center. Report on the climate risks in the Russian Federation. (2017)

Roshydromet. Macroeconomic impacts of climate change for Russian Federation up to 2030 and beyond. (2011)

Roshydromet. Second assessment report on climate change and its consequences in Russian Federation (2014)

Serov N., Peters A., Osipova T.. Adaptation of electric grid systems to climate change // Proceedings of the Voeikov Main Geophysical Observatory. 2016, No. 581, pp. 116-137

Streletskiy D., Anisimov O., Vasiliev A., Permafrost Degradation. In: W. Haeberly and C. Whiteman (Eds.). Snow and Ice-Related Hazards, Risks and Disasters. Chapter 10, 2014, Elsevier, pp. 303–344.

Streletskiy D., Shiklomanov N. Geotechnical safety issues in the cities of Polar Regions, Geography, Environment, Sustainability, 2012, 5(3), pp. 104–119

The Demographic Yearbook of Russia. 2017: Statistical Handbook/Rosstat. – M., 2017. – 263 pp

UNFCCC. GHG Emissions profile for Russian Federation. 2018. http://di.unfccc.int/ghg_profile_annex1

Unified Energy System of Russia (2019): Report on the functioning of the Unified Energy System of Russia in 2018.https://www.so-ups.ru/fileadmin/files/company/reports/disclosure/2019/ups_rep2018.pdf.

Vasilyev M.. International experience in developing national adaptation plans for climate change (structure, goals, outcomes, responsibilities) // Proceedings of the Voeikov Main Geophysical Observatory. 2017, No. 585, pp. 110-125.

WWF (n.d.). Adaptation to Climate Change. https://new.wwf.ru/what-we-do/climate-and-energy/adaptation-to-climate-change/

Urban green spaces and spatial planning

Announce of "popular inventory of Saint Petersburg green spaces" campaign by ECOM in 2010: http://www.ecom.su/an nouncements/index.php?id=1360

Eurasianet (2019): Russia: will the protests make listeners to the defenders of parks and squares? Eurasia.net, 23.07.2019 https://russian.eurasianet.org/.

Kashnitsky, N.Mkrtchyan, O.Leshukov. (2016): Interregional Youth Migration in Russia: A Comprehensive Analysis of Demographic Statistical Data I.Educational Studies. Moscow. 2016. No 3. P. 169–203. Retrieved at: https://vo.hse.ru/data/2016/10/17/1109140103/Kashnitsky%20EN%20(2).pdf

Legislation of Russian Federation in the field of urban planning, list of laws and norms on the site of the Committee on Urban Planning and Architecture of Saint Petersburg, http://kgainfo.spb.ru/zakon/zakonodatelstvo-rossijskoj-federacii/

ONF Year of Ecology Report (2017): Published in 2018 on https://onf.ru/sites/default/files/projects_docs/itogovyy_doklad_onf_po_godu_ekologii_-_2017.pdf.

Public polls about recycling in Russia, 2018 г. https://onf.ru/2018/01/22/opros-onf-88-grazhdan-vystupayut-za-razdelnyy-sbor-musora/.

Presidential Decree № 204 «On national goals and strategic objectives of development of Russian Federation until year2024», published on May 7, 2018 at http://kremlin.ru/events/president/news/57425

Site of Krasivy Peterburg (“Beautiful Petersburg”) civic movement, with list of public campaigns on different issues, including illegal advertising on http://красивыйпетербург.рф/about

Site of Municipal Council of the City of Perm: http://www.gorodperm.ru/actions/building-up/gradostroi/genplan/ma ster_plan/

Thenatureofcities (2016): St. Petersburg: Towards Integrated and Sustainable Green Infrastructure by Maria E Ignatieva, Perth. Published on The Nature of Cities on September 18, 2013, retrieved at https://www.thenatureofcities.com/2013/09/18/st-petersburg-towards-integrated-and-sustainable-green-infrastructure/

Urban Environment Quality Index, (2017): Strelka Institute and Ministry of Construction of Russian Federation, 2017. Available at https://индекс.дом.рф

Urban Environment Quality Index (2018). Russian Ministry of Construction. https://www.minstroyrf.ru/docs/19126/.

Waste generation and management

Accounts Chamber (2020): Report on the results of the expert-analytical event "Monitoring the implementation of the activities of the national project" Ecology ", including the timeliness of their financial support, achievement of goals and objectives, milestones, as well as the quality of management", January 2020 http://audit.gov.ru/activities/control/%D0%AD%D0%BA%D0%BE%D0%BB%D0%BE%D0%B3%D0%B8%D1%8F%202020-01-15%20[1].pdf.

A list of goods and production, including packaging, obligatory for recycling (also partial recycling) http://static.government.ru/media/files/NW4mq3VmrOJPBw3JtvlNPcxv1tMF3kKn.pdf

A list of production and consumption waste prohibited to be buried at landfills (due to useful components). http://docs.cntd.ru/document/436754215

Governmental committee on production and consumption waste management (Government decree, 2017), http://government.ru/info/30563/

Government of Russian Federation (2019): On amendments to certain legislative acts of the Russian Federation regarding improvement of legislation in the field of environmental protection. https://sozd.duma.gov.ru/bill/568200-7.

Greenpeace (2019): Why burning is not recycling. https://greenpeace.ru/blogs/2019/12/18/legkim-dvizheniem-ruki-szhiganie-prevrashhaetsja-v-bezobidnuju-utilizaciju/.

Ministry of Energy (2019): Basic Characteristics of the Russian Power Electricity. https://minenergo.gov.ru/node/532

Public polls about recycling in Russia, 2018 r. https://onf.ru/2018/01/22/opros-onf-88-grazhdan-vystupayut-za-razdelnyy-sbor-musora/

Report „On the state and protection of environment in Russian Federation in 2016“ http://194.87.66.197/gosdoklad-eco-2016/waste.html

Strategy for development of recycling and production and consumption waste management in Russia till 2030 http://static.government.ru/media/files/y8PMkQGZLfbY7jhn6QMruaKoferAowzJ.pdf

Standards for waste disposal and recycling http://static.government.ru/media/files/k8qAWg0Iz7AAqAo92iksmtc7AAvsWCSk.pdf

India

Ahire, K. D., Huddar, K. R., Todkar, J. V., Bhosale, A. A., & Ranadive, S. G. (2017). Study on Unneccessary Honking During Red Traffic Signals in Urban Area With Special Reference to Kolhapur City. Journal of Emerging Technologies and Innovative Research (JETIR) , 4 (10), 91-92.

Ahluwalia , I. J. (30. November 2016). Cities at crossroads: Recycling begins at home. Abgerufen am 23. May 2018 von The Indian Express: http://indianexpress.com/article/opinion/columns/waste-recycling-organic-enerygy-garbage-management-disposal-pollution-metro-cities-4402086/

Aman, H. (23. October 2017). A Comprehensive Study Of Air Pollution In India. Abgerufen am 31. January 2018 von Youth Ki Awaaz: https://www.youthkiawaaz.com/2017/10/a-comprehensive-study-of-air-pollution-in-india/

ASSOCHAM. (2017). Waste Management in India - Shifting Gears. PwC India.

Beermann, J., Damodaran, A., Jörgensen, K., & Schreurs, M. A. (2016). Climate action in Indian cities: an emerging new research area. Journal of Integrative Environmental Sciences , 13 (1), S. 55-66.

Biswas, A. K., & Hartley, K. (20. December 2017). Delhi should follow Beijing’s example in tackling air pollution. Abgerufen am 27. January 2018 von The Conversation: Academic rigour, journalistc flair: https://theconversation.com/delhi-should-follow-beijings-example-in-tackling-air-pollution-89378

Butler, N. (09. April 2018). India is the pivotal state in climate change stakes. Abgerufen am 30. May 2018 von Financial times: https://www.ft.com/content/65327fd4-374d-11e8-8b98-2f31af407cc8

Chandrasekar, G. (n.d.). No 'Horn Ok' Please! Abgerufen am 17. May 2018 von parentcircle: https://www.parentcircle.com/article/no-horn-ok-please/

Chatterjee, B. (19. October 2017). Six nullahs are polluting Mithi river in Mumbai, says survey. Abgerufen am 28. May 2018 von hindustan times: https://www.hindustantimes.com/mumbai-news/six-nullahs-are-polluting-mithi-river-in-mumbai-says-survey/story-adn4xtxJ3iO1KNfYrVj78L.html

Chaudhary, N. (2018). India Policy Environment Paper. Abgerufen am 03. July 2018 von Urban Pathways: https://www.urban-pathways.org/uploads/4/8/9/5/48950199/up_india_pep_small.pdf

Chauhan, C. (20. September 2017). Extreme weather in India taking a toll on people and economy. Abgerufen am 30. May 2018 von Hindustan Times: https://www.hindustantimes.com/india-news/extreme-weather-in-india-taking-a-toll-on-people-and-economy/story-JfLjOagMf2aMI80O1YETQL.html

Chowdhury, S., & Dey, S. (2016). Cause-specific premature death from ambient PM2.5 exposure in India: Estimate adjusted for baseline mortality. Environment International , 91, 283-290.

CPCB. (22. February 2018). CPCB Introduction. Abgerufen am 31. May 2018 von Central Pollution Control Board: http://cpcb.nic.in/Introduction/.

CSE. (27. December 2016). A Clean Air Tool for Cities. Abgerufen am 31. May 2018 von Centre for Science and Environment: Air Pollution: http://www.cseindia.org/a-clean-air-tool-for-cities-7789

CSE. (13. January 2018). CSE welcomes latest Supreme Court direction to environment ministry. Abgerufen am 20. January 2018 von Centre for Science and Environment: Air pollution: http://www.cseindia.org/cse-welcomes-latest-supreme-court-direction-to-environment-ministry-8318

CSE. (22. May 2014). Water and Wastewater Management: Overview. Abgerufen am 20. May 2018 von Centre for Science and Environment: https://www.cseindia.org/cse-is-the-center-of-excellence-coe-for-sustainable-water-management-1821

Deccan Chronicle. (09. December 2017). Kochi to take on air pollution. Abgerufen am 24. March 2019 von https://www.deccanchronicle.com/nation/in-other-news/091217/kochi-to-take-on-air-pollution.html

Deccan Chronicle. (25. November 2016). Kochi unaware of noise pollution. Abgerufen am 10. March 2019 von Deccan Chronicle: https://www.deccanchronicle.com/nation/in-other-news/251116/kochi-unaware-of-noise-pollution.html

Drishti. (13. November 2015). Article 21 of the Constitution of India - Right to Life and Personal Liberty. Abgerufen am 28. May 2018 von Academike: https://www.lawctopus.com/academike/article-21-of-the-constitution-of-india-right-to-life-and-personal-liberty/

Dutta, S. (22. September 2017). 76 Million Don't Have Safe Drinking Water: India's Looming Water Crisis. Abgerufen am 24. May 2018 von NDTV: https://swachhindia.ndtv.com/76-million-dont-have-safe-drinking-water-indias-looming-water-crisis-5606/

EPCA. (2017). Report No. 71, Comprehensive Action Plan for air pollution control with the objective to meet ambient air quality standards in the National Capital Territory of Delhi and National Capital Region, including states of Haryana, Rajasthan and Uttar Pradesh. Environment Pollution (Prevention and Control) Authority.

Garg, N., Sinha, A., Dahiya, M., Gandhi, V., Bhardwaj, R., & Akolkar, A. (2017). Evaluation and Analysis of Environmental Noise Pollution in Seven Major Cities of India. Archives of Acoustics , 42 (2), 175-188.

GBD MAPS Working Group. (2018). Burden of Disease Attributable to Major Air Pollution Sources in India: Summary for Policy Makers. Health Effects institute. Boston, USA: Health Effects institute.

Ghosal, A., & Chatterjee, P. (02. April 2015). Landmark study lies buried: How Delhi's poisonous air is damaging its children for life. Abgerufen am 28. January 2018 von http://indianexpress.com/article/india/india-others/landmark-study-lies-buried-how-delhis-poisonous-air-is-damaging-its-children-for-life/

Goswami, S. (08. November 2017). Not just Delhi, severe air pollution has taken several other cities hostage. Abgerufen am 26. January 2018 von Down to Earth: http://www.downtoearth.org.in/news/not-just-delhi-severe-air-pollution-has-taken-several-other-cities-hostage-59050

Government of India. (2015). India's Intended Nationally Determined Contribution.

Government of India. (2016). Municipal Solid Waste Management Manual. Ministry of Urban Development. Central Public Health and Environmental Engineering Organisation (CPHEEO).

Hindustan Times. (18. October 2017). Indian cities must become ‘sponge cities’ to tackle urban flooding. Abgerufen am 31. May 2018 von Hindustan Times: https://www.hindustantimes.com/editorials/india-cities-must-become-sponge-cities-to-tackle-urban-flooding/story-QYnkjNFus3RtW6JPfXCJrI.html

Hunashal, R. B., & Patil, Y. B. (2012). Assessment of Noise Pollution Indices in the City of Kolhapur, India. Procedia - Social and Behavioral Sciences , 37, 448-457.

Imam, A. U., & Banerjee, U. K. (2016). Urbanisation and greening of Indian cities: Problems, practices, and policies. Ambio , 45 (4), 442-457.

indiaonline. (n.d.). Noise Pollution in India. Abgerufen am 18. May 2018 von http://www.indiaonline.in/about/profile/geography/environmentalconcerns/noise-pollution

Jörgensen, K., & Wagner, C. (18. April 2017). Low Carbon Governance in Multi-level Structures: EU–India relations on energy and climate. Environment Policy and Governance , 27 (2), S. 137-148.

Jamir, L., Nongkynrih, B., & Gupta, S. K. (2014). Community Noise Pollution in Urban India: Need for Public Health Action. Indian Journal of Community Medicine , 39 (1), 8-12.

Krishnan, M. (06. June 2017). Sizzling heat wave hits hard India's poor. Abgerufen am May 30 2018 von DW Asia: http://www.dw.com/en/sizzling-heat-wave-hits-hard-indias-poor/a-39132648

Kumar, S., Smith, S., Fowler, G., Velis, C., Kumar, S., Arya, S., et al. (22. March 2017). Challenges and opportunities associated with waste management in India. Abgerufen am 23. May 2018 von Royal Society Open Science: http://rsos.royalsocietypublishing.org/content/4/3/160764

Lahiry, S. (09. January 2017). India's challenges in waste management. Abgerufen am 24. May 2018 von Down To Earth: http://www.downtoearth.org.in/blog/india-s-challenges-in-waste-management-56753

Lahiry, S. (13. July 2017). Why India needs to change the way it manages water resources. Abgerufen am 24. May 2018 von http://www.downtoearth.org.in/blog/challenges-in-the-management-of-water-in-india-58275

Lalchandani, D., and Maithel, S. (2013): Towards Cleaner Brick Kilns in India. A Win-Win approach based on zig-zag firing technology. In: Greentech Knowledge Solutions. http://www.hablakilns.com/wp-content/uploads/2018/03/Greentech-India-ZZ-a-win-win-_Brick-kiln-policy-brief_-March-2013.pdf.

Lanzi, E., & Dellink, R. (14. November 2017). Urgent action on air pollution in India makes economic sense. Abgerufen am 28. January 2018 von OECD Insights: http://oecdinsights.org/2017/11/14/urgent-action-on-air-pollution-in-india-makes-economic-sense/

livemint. (15. February 2016). Mumbai noisiest city in India, study finds. Abgerufen am 17. May 2018 von https://www.livemint.com/Politics/1k4OIDkaGfm9WKuYiqNJBK/Mumbai-noisiest-city-in-India-study-finds.html

LSE. (2008). National Action Plan on Climate Change. Abgerufen am 03. July 2018 von The London School of Economics and Political Science: http://www.lse.ac.uk/GranthamInstitute/law/national-action-plan-on-climate-change/

Magagula, S. (n.d.). Noise - The Silent Killer: Noise Pollution & Urban Health. Abgerufen am 17. May 2018 von Healing Places: http://www.healingplaces.nl/single-post/2018/03/20/Noise---The-Silent-Killer-Noise-Pollution-Urban-Health

Mathew, D. M., & Dhanuraj, D. (2017). Defending Decentralisation in Kerala: Probing the Autonomy of Kerala's Urban Local Bodies. Centre for Public Policy Research.

Maurya, L., & Goswami, S. (n.d.). While Delhi Chokes Other Cities Also Get a Whiff Toxic Air. Abgerufen am 20. January 2018 von Down to Earth: http://www.downtoearth.org.in/dte-infographics/while_delhi_chokes.html

MDWS. (2018). Ministry of Drinking Water and Sanitation: About Us. Abgerufen am 28. May 2018 von https://mdws.gov.in/about-us

Miglani, D. (2015). Noise Pollution: Sources, Effects and Control. Abgerufen am 17. May 2018 von Legal Service India: http://www.legalserviceindia.com/articles/noip.htm

Ministry of Law and Justice. (2003). The Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003. Ministry of Law and Justice, New Delhi.

Mitra, P. (22. May 2013). Open space shrinking, city gasps for breath. Abgerufen am 30. May 2018 von The Times of India: https://timesofindia.indiatimes.com/city/kolkata/Open-space-shrinking-city-gasps-for-breath/articleshow/20188789.cms

MNRE. (2018). Ministry of New and Renewable Energy, Government of India. Abgerufen am 15. January 2018 von https://mnre.gov.in/

MoEFCC. (2018). Hazardous Substances Management: Publications. Abgerufen am 24. May 2018 von Ministry of Environment, Forest and Climate Change: http://envfor.nic.in/division/reportguidelines

MoEFCC. (2015). Ministry of Environment, Forest and Climate Change, Government of India. Abgerufen am 15. January 2018 von http://envfor.nic.in/about-ministry/about-ministry

MoHUA. (2017). Ministry of Housing and Urban Affairs, Government of India. Abgerufen am 16. January 2018 von http://mohua.gov.in/cms/mandate.php

MoHUA. (12. April 2017). Smart Cities Mission: Strategy. Abgerufen am 29. May 2018 von http://smartcities.gov.in/content/innerpage/strategy.php

MoP. (2018). Ministry of Power, Government of India. Abgerufen am 17. January 2018 von http://powermin.nic.in

MoRTH. (2018). Ministry of Road Tranport & Highways, Government of India. Abgerufen am 17. January 2018 von http://morth.nic.in/index1.asp?lang=1&linkid=10&lid=144

MoUD. (2014). National Urban Transport Policy, 2014. Ministry of Urban Development, Government of India.

Nair, S. (2008). Challenges to the biodiversity in a fast-growing tropical city. In N. Müller, D. Knight, & P. Werner (Hrsg.), Urban Biodiversity & Design: Implementing the Convention on Biological Diversity in towns and cities. Bonn, Germany: BfN.

Nambudiri, S. (20. March 2017). Battling the wave of climate change. Abgerufen am 10. April 2019 von The Times of India: https://timesofindia.indiatimes.com/city/kochi/battling-the-wave-of-climate-change/articleshow/57725047.cms

Narain, S., & Roychowdhury, A. (2016). Towards a Clean Air Action Plan: Lessons from Delhi. New Delhi, India: Centre for Science and Environment.

NBR. (August 2013). India's water crisis: Causes and Cures. Abgerufen am 24. May 2018 von The National Bureau of Asian Research: http://www.nbr.org/downloads/pdfs/outreach/NBR_IndiaCaucus_August2013.pdf

NITI Aayog. (04. December 2017). NITI Aayog: Overview. Abgerufen am 30. May 2018 von National Institution for Transforming India: http://niti.gov.in/content/overview#

Pamnani, A., & Srinivasarao, M. (February 2014). Municipal Solid Waste management in India: A Review and Some New Results. International Journal of Civil Engineering and Technology (IJCIET) , 5 (2).

Planning Commision. (2014). Report of the Task Force on Waste to Energy (Volume 1) in the context of Integrated MSW Management. Abgerufen am 23. May 2018 von Planning Commission: http://planningcommission.nic.in/reports/genrep/rep_wte1205.pdf

Rajagopal, S. (25. February 2019). Pollution from waste burning may linger for days. Abgerufen am 05. May 2019 von thehindu.com: https://www.thehindu.com/news/cities/Kochi/pollution-from-waste-burning-may-linger-for-days/article26367880.ece

Sangonet Pulse. (15. 03 2018). Environment. Abgerufen am 18. 07 2018 von Sangonet Pulse: http://www.ngopulse.org/press-release/%E2%80%8Bdespite-severe-health-impacts-eskom-again-seeks-delay-compliance-air-pollution

Seetharaman, G. (25. June 2017). India wants to double consumption of cheap material in 5 years, what about its plastic waste? Abgerufen am 23. May 2018 von The Economic Times: https://economictimes.indiatimes.com/industry/indl-goods/svs/paper-/-wood-/-glass/-plastic/-marbles/india-

wants-to-double-consumption-of-cheap-material-in-5-yrs-what-about-its-plastic-waste/articleshow/59301057.cms

Suchitra, M. (2015a). Kerala becomes first state in country to complete formation of biodiversity management committees. Abgerufen am 15. May 2019 von DownToEarth: https://www.downtoearth.org.in/news/kerala-becomes-first-state-in-country-to-complete-formation-of-biodiversity-management-committees-39335

Suchitra, M. (08. September 2015). Water quality deteriorating in Kochi, reveals audit. Abgerufen am 23. April 2019 von DownToEarth: https://www.downtoearth.org.in/news/water/water-quality-deteriorating-in-kochi-reveals-audit-51031

TERI. (2017). Final Report on Urban Planning Characteristics to Mitigate Climate Change in Context of Urban Heat Island Effect. Bangalore: The Energy and Resources Institute.

TERI. (2015). Green Growth and Climate Mitigation in India. The Energy and Resources Institute, Global Green Growth Institute.

The new Indian Express. (14. July 2015). Kerala Perspective Plan 2030 Unveiled. Abgerufen am 05. May 2019 von The new Indian Express: http://www.newindianexpress.com/cities/thiruvananthapuram/2015/jul/14/Kerala-Perspective-Plan-2030-Unveiled-783617.html

The new Indian Express. (11. March 2019). Kochi: Keeping decibels in check. Abgerufen am 20. March 2019 von The new Indian Express: http://www.newindianexpress.com/cities/kochi/2019/mar/11/kochi-keeping-decibels-in-check-1949392.html

The Times of India. (09. June 2016). Noise pollution in Delhi is a killer too. Abgerufen am 17. May 2018 von The Times of India: City: https://timesofindia.indiatimes.com/city/delhi/Noise-pollution-in-Delhi-is-a-killer-too/articleshow/52674844.cms

The Times of India. (28. February 2018). Sea-level rise in 30 years a threat to chennai. Abgerufen am 30. May 2018 von The Times of India: https://timesofindia.indiatimes.com/city/chennai/sea-level-rise-in-30-years-a-threat-to-chennai/articleshow/63057586.cms

Thomas, G., ShareekulAnsar, S. A., & Zachariah, E. (2014). Analysis of urban heat island in Kochi, India, using a modified local climate zone classification. Procedia Environmental Science , 21, 3-13.

Times of India. (23. March 2018). Is Day Zero on the horizon? Taps could run dry in Bengaluru, Pune. Abgerufen am 23. May 2018 von The Times of India: https://timesofindia.indiatimes.com/india/bengaluru-pune-among-200-cities-facing-serious-water-crisis/articleshow/63411386.cms

Vachana, V. R. (01. September 2017). India’s Urban Floods Are More Acts Of Man Than God. Abgerufen am 31. May 2018 von Huffpost: https://www.huffingtonpost.in/v-r-vachana/india-s-urban-floods-are-more-acts-of-man-than-god_a_23191850/

WRI-CAIT. (2015). Historic Emissions: India. Abgerufen am 30. May 2018 von World Resources Institute, CAIT Climate Data Explorer: http://cait.wri.org/profile/India#Country%20GHG%20Emissions

Yedla, S. (30. April 2016). India's waste management problems are piling up. Abgerufen am 24. May 2018 von http://www.eastasiaforum.org/2016/04/30/indias-waste-management-problems-are-piling-up/

China

[ADB] Asian Development Bank (2017): Water–Energy Nexus in the People’s Republic of China and Emerging Issues. https://www.adb.org/publications/water-energy-nexus-prc

Bateman, Joshua (2014): China’s looming water crisis. In: The Ecologist.

Central People's Government of the P.R.C (2013): the Views of the State Council on Applying the Strictest Water resources Control System. http://www.gov.cn/zwgk/2013-09/12/content_2486773.htm

Central People's Government of the P.R.C (2017): National carbon trading market is kicked off. http://www.gov.cn/xinwen/2017-12/20/content_5248687.htm

Chen, Ruishan et al. (2014): China's Soil Pollution: Farms on the Frontline. In: Science, 344 (6185), 2014, pp. 691. DOI: 10.1126/science.344.6185.691-a

Cosier, Martin & Shen, Dajun (2009): Urban Water Management in China. In: Water Resources Development, 25(2), 2009, pp. 249-268, DOI: 10.1080/07900620902868679

Dai, Liping et al. (2016): Governance of the Sponge City Programme in China with Wuhan as a case study. In: International Journal of Water Resources Development. DOI: https://doi.org/10.1080/07900627.2017.1373637

[EF] Energy Foundation (n.a.): Policy Research on Construction Waste Recycling and Reutilization (in Chinese). http://www.efchina.org/Attachments/Report/reports-20140630-zh/%E5%BB%BA%E7%AD%91%E5%9E%83%E5%9C%BE%E5%9B%9E%E6%94%B6%E5%9B%9E%E7%94%A8%E6%94%BF%E7%AD%96%E7%A0%94%E7%A9%B6.pdf

[FoN] Friends of Nature (2015): Information disclosure of160 MSW incineration plants. http://www.fon.org.cn/?option=com_k2&view=item&id=124:160

Gao, S. and Wang, K.(2013). The houses built on China's 'poisoned' land. https://www.chinadialogue.net/article/show/single/en/6070-The-houses-built-on-China-s-poisoned-land

Global Carbon Budget 2017, by Corinne Le Quéré et al. (2017): Earth System Science Data Discussions, DOI: 10.5194/essdd-2017-123.

Greenpeace (2014): Governmental annual report shows the severity of soil pollution. http://www.greenpeace.org/china/zh/news/releases/toxics/2014/04/chinese-solid-pollution-report/

Greenpeace (2018): The rank of PM2.5 level among 365 cities. http://www.greenpeace.org.cn/air-pollution-2017-city-ranking/#_ftn5

Guan, Dabo & Liu, Zhu (n.a.): Tracing Back the Smog: Source Analysis and Control Strategies for PM2.5 Pollution in Beijing-Tianjin-Hebei. Greenpeace: China Environment Press, Beijing, China. Available at: http://m.greenpeace.org/eastasia/Global/eastasia/publications/reports/climate-energy/2013/Tracing%20back%20the%20smog%20(English%20full%20report).pdf

Güneralp,Burak et al. (2015): Balancing urban growth and ecological conservation: A challenge for planning and governance in China. In: Ambio, 44(6), 2015, pp. 532–543. DOI: 10.1007/s13280-015-0625-0

He, Chunyang et al. (2014): Urban expansion dynamics and natural habitat loss in China: a multiscale landscape perspective. In: Global Change Biology, 2014. DOI: 10.1111/gcb.12553

Henderson, Geoffrey et al. (2016): 5 Questions: What Does China's New Five-Year Plan Mean for Climate Action?, World Resources Institute. http://www.wri.org/blog/2016/03/5-questions-what-does-chinas-new-five-year-plan-mean-climate-action

Hong, Y. et al. (2014): China's soil pollution: urban brownfields. IN Science344(6185):691-2. doi: 10.1126/science.344.6185.691-b

Hu, Xi et al. (2016): The spatial exposure of the Chinese infrastructure system to flooding and drought hazards. In: Natural Hazards, 80(2), 2016, pp 1083–1118. DOI: https://doi.org/10.1007/s11069-015-2012-3

Hu, Xueyan (2016): China's soil plan needs strong support. In: Nature 536, 375. DOI:10.1038/536375a

Kalisch, D., Wüstemann, H., Chen, W.Y., Chen, B. (2017). Integrating the Value of Biodiversity and Ecosystem Services into Ur ban Policy in China and Germany. Technische Universität Berlin, Germany.

Li, Yanlong et al. (2016): Future Development of Waste Management in China According to the 13th Five-Year Plan. Available at: http://www.vivis.de/phocadownload/Download/2016_wm/2016_WM_139-146_Li.pdf

Liu, J.G. and Yang, W. (2012): Water Sustainability for China and Beyond. Science, 337 (10), 649-650. DOI: 10.1126/science.1219471

McDonald RI, Marcotullio PJ, Guneralp B (2013): Urbanization and global trends in biodiversity and ecosystem services. In: Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities. (eds Elmqvist T, Fragkias M, Goodness J, Guneralp B, Marcotullio PJ, Mcdonald RI, Parnell S, Schewenius M, Sendstad M, Seto KC, Wilkinson C), pp. 31–52. Springer, The Netherlands

Ministry of Ecology and Environment of P.R.C (2016): Brief on air pollution reduction: http://www.mep.gov.cn/hjzli/dqwrfz/dqwrfzxdjh/201609/P020160922582265655731.pdf?COLLCC=1333834638&

[MEP] Ministry of Ecology and Environment (2010): National Biodiversity Conservation Action Plan 2011-2030. http://www.mep.gov.cn/gkml/hbb/bwj/201009/t20100921_194841.htm?COLLCC=1334947611&

[MEP] Ministry of Environmental Protection (2014): China's Fifth National Report on the Implementation of the Convention on Biological Diversity. https://www.cbd.int/doc/world/cn/cn-nr-05-en.pdf

[MEP & MLR] Ministry of Environmental Protection and Ministry of Land and Resources of P.R.C (2014): Reports on China's Soil Pollution Survey. www.zhb.gov.cn/gkml/hbb/qt/201404/t20140417_270670.htm [in Chinese].

[MoST] Ministry of Science and Technology of the P.R.C. (2015): Action Plan of Water Pollution Reduction. http://www.most.gov.cn/yw/201504/t20150416_119031.htm

[MoHURD] Ministry of Housing and Urban-Rural Development (2017): Statistic book of urban infrastructure. http://www.mohurd.gov.cn/xytj/tjzljsxytjgb/

[MWR] Ministry of Water Resources (2012): China Water Resource Report 2011

[NDRC] National Development and Reform Commission(2015a):Annual report of resource utilization in China in 2014

[NDRC] National Development and Reform Commission(2015b):Action Plan of promoting circular economy in 2015

[NDRC] National Development and Reform Commission(2016):13th Five Year Plan (2016-2020) of residential MSW treatment and facility construction

Nature Conservancy, The (2016): China's Urban Water Blueprint. Beijing, China: The Nature Conservancy. Available from nature.org/waterblueprint.

People (2014) Beijing daily waste amounted to 184000 ton. Available from http://history.people.com.cn/peoplevision/n/2014/1029/c371454-25930420.html

Reuters (Apr 1st 2015):China to unveil measures to fight water pollution. https://www.reuters.com/article/us-china-environment-water/china-to-unveil-measures-to-fight-water-pollution-idUSKBN0MS3XQ20150401

Shan, Yuli et al. (2017): China CO2 emission accounts 1997–2015. In: Scientific Data, 5, 2017, pp. unknown. DOI: 10.1038/sdata.2017.201

Song, Ranping et al. (2015): Assessing Implementation of China's Climate Policies in the 12th 5-Year Period - Working Paper. World Resources Institute, Washington.

Strauss, B. H., Kulp, S. and Levermann, A. (2015): Mapping Choices: Carbon, Climate, and Rising Seas, Our Global Legacy. Climate Central Research Report. pp. 1-38. Available at: http://sealevel.climatecentral.org/uploads/research/Global-Mapping-Choices-Report.pdf

The Economist (Jun 8th 2017):The most neglected threat to public health in China is toxic soil. https://www.economist.com/briefing/2017/06/08/the-most-neglected-threat-to-public-health-in-china-is-toxic-soil

Tianjin Environmental Protection Bureau (2017): Tianjin Environmental Statement 2016. Available at: http://www.tjhb.gov.cn/root16/mechanism/standard_monitoring_of_the_Department_of_science_and_technology/201706/P020170605593040876560.pdf

UNEP (2015): The Climate and Environmental Benefits of Controlling SLCPs in P.R. China. United Nations Environment Programme (UNEP), Nairobi, Kenya. Available at: https://wedocs.unep.org/bitstream/handle/20.500.11822/9749/-The_Climate_and_Environmental_Benefits_of_Controlling_SLCPs_in_PR_China_A_UNEP-PRCEE_Synthesis_Report-2015Benefit_of_Controlling_SLCP_in_China_Engli.pdf?sequence=4&isAllowed=y

Xie, J. et al. (2009). Addressing China's Water Scarcity: Recommendations for Selected Water Resource Management Issues. World Bank Publications

Xie YJ & Ng CN (2013): Exploring spatiotemporal variation in habitat loss and its causal factors in the Shenzhen River cross-border watershed. In: Applied Geography, 39, 2013, pp. 140–150.

Yang, H. et al. (2012): Industry: Rural factories won't fix Chinese pollution. In: Nature, 18; 490(7420):342-3. DOI: 10.1038/490342d.

Yao, Yijun (2016): Pollution: Spend more on soil clean-up in China. In: Nature 533, 469. DOI: 10.1038/533469a

Yixuan Zheng et al. (2017): Air quality improvements and health benefits from China's clean air action since 2013. In: Environmental Research Letters, 12(11), 2017, pp. unknown. DOI: 10.1088/1748-9326/aa8a32

Zhang, Chun (2017): Can China meet its 2017 air quality goals? https://www.chinadialogue.net/article/show/single/en/9574-Can-China-meet-its-2-17-air-quality-goals-

South Africa

Altieri, Katye & Keen, Samantha (2016): The cost of Air Pollution in South Africa. https://www.theigc.org/blog/the-cost-of-air-pollution-in-south-africa/

Balch, Oliver (2015): Radioactive City: How Johannesburg´s Townships are Paying for its Mining Past. https://www.theguardian.com/cities/2015/jul/06/radioactive-city-how-johannesburgs-townships-are-paying-for-its-mining-past.

Barbee, Jeff (2015): Insurance Firm Turns to Planting Trees in South Africa to Combat Drought Risk. https://www.theguardian.com/environment/2015/dec/23/insurance-company-turns-planting-trees-south-africa-combat-drought-risk.

Bizcommunity. (05. 04 2018). Climate Change and its affect on healthcare systems. Bizcommunity .

Boccaletti, Guilio, Stuchtey, Martin & Van Olst, Marc (2010): Confronting South Africa´s Water Challenge. https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/confronting-south-africas-water-challenge.

Brownlie, Susie; von Hase, Amrei; Botha, Mark; Manuel, Jeffrey, Balmforth, Zoe & Jenner, Nicky (2017): Biodiversity Offsets in South Africa – Challenges and Potential Solutions. https://www.tandfonline.com/doi/full/10.1080/14615517.2017.1322810.

Burnell, M. (22. 08 2017). Climate change is definitely affecting SA Businesses . Business report .

Cadman, Mandy; Petersen Caroline; Driver, Amanda; Sekhran, Nik; Maze, Kristal & Munzhedzi, Shonisani (2010): Biodiversity for Development: South Africa´s Lanscape Approach to Conserving Biodiversity and

Promoting Ecosystem Resilience. https://www.sanbi.org/wp-content/uploads/2018/04/biodiversity-development-primer.pdf.

Cape Town Green Map (n.d.): Local Biodiversity Facts. http://www.capetowngreenmap.co.za/go-green/biodiversity-facts.

[CDH] Cliffe Dekker Hofmeyr (2019): The Integrated Resource Plan 2019: A Promising Future Roadmap for Generation Capacity in South Africa. https://www.cliffedekkerhofmeyr.com/en/news/publications/2019/Corporate/energy-alert-22-october-The-Integrated-Resource-Plan-2019-A-promising-future-roadmap-for-generation-capacity-in-South-Africa.html.

Centre for Environmental Rights in South Africa (n.d.). https://cer.org.za/virtual-library/legislation.

Cilliers, Sarel Stephanus & Siebert, Stefan John (2012): Urban Ecology in Cape Town: South African Comparisons and Reflections. http://dspace.nwu.ac.za/handle/10394/9929.

City of Cape Town (n.d.): Critical Water Shortages Disaster Plan. http://www.capetown.gov.za/Family%20and%20home/residential-utility-services/residential-water-and-sanitation-services/critical-water-shortages-disaster-plan.

Climate Transparency (2017): Brown to Green: The G20 Transition to a Low-Carbon Economy. http://www.climate-transparency.org/wp-content/uploads/2017/07/B2G2017-SouthAfrica.pdf.

de Greef, K. (19. 01 2018). Rising seas from warming climate threaten major cities in Africa. news24 .

De Jong, Feike (2017): Which is the World´s Most Biodiverse City? https://www.theguardian.com/cities/2017/jul/03/which-worlds-most-biodiverse-city-extreme-cities.

Department of Energy (n.d.): http://www.energy.gov.za/files/au_frame.html.

Department of Environmental Affairs, South Africa (2012): Healthy Soil Sustains Your Life: Let´s Go Land-Degradation Neutral. Desertification in South Africa. http://soer.deat.gov.za/dm_documents/World_Day_to_Combat_Desertification_ThemeArticle_17June_t1w1u.pdf.

Department of Environmental Affairs, South Africa (2012): National Waste Information Baseline Report. http://sawic.environment.gov.za/documents/1880.pdf.

Department of Environmental Affairs, South Africa (n.d.): Land Degradation. http://soer.deat.gov.za/47.html.

Department of Environmental Affairs (2017): Operation Phakisa – Chemicals and Waste Economy. https://www.environment.gov.za/projectsprogrammes/operationphakisa_chemical_waste_economy.

Department Water and Sanitation South Africa (2016): A Review of Water Quality Management Instruments in South Africa. http://www.dwa.gov.za/projects/iwqms/Documents/Report%201.2.3_Review%20of%20WQM%20Instruments%20for%20SA_Inaugural%20Report.pdf.

[EC] European Commission (2020): South Africa. Areas of cooperation. https://ec.europa.eu/clima/policies/international/cooperation/south-africa_en#:~:text=South%20Africa%20aims%20to%20limit,decarbonised%20electricity%20by%202050

[ECOSOC] United Nations Economic and Social Council (2007). Economic Commission for Africa. Africa Review Report on Drought and Desertification. http://www.un.org/esa/sustdev/csd/csd16/rim/eca_bg3.pdf.

England, Charlotte (2016): Drought Devastates Lesotho as Water Is Exported to South Africa. https://www.independent.co.uk/news/world/africa/drought-lesotho-water-exported-south-africa-katse-dam-food-insecurity-a7189211.html.

[EDF and IETA] Environmental Defence Fund & International Emissions Trading Association (2014): South Africa: The Wold´s Carbon Markets: A Case Study Guide to Emissions Trading. https://www.edf.org/sites/default/files/South-Africa-Case-Study-March-2014.pdf.

ENCA (2016): South Africa´s Battle for Clean Air. https://www.enca.com/coverage/south-africas-battle-clean-air.

[ENVASS] Environmental Assurance (2017): Introduction of Local Air Quality Management in South Africa: Overview and Challenges. http://www.envass.co.za/introduction-of-local-air-quality-management-in-south-africa-overview-and-challenges/.

[GEF] Global Environmental Facility (2018): Sheperding Back our Biodiversity. https://www.thegef.org/news/shepherding-back-our-biodiversity.

Government of South Africa (n.d.): Economic and Social Rights Report: Chapter 8. The Right to Sufficient Water. https://www.sahrc.org.za/home/21/files/Reports/3rd%20ESR%20Report%20chapter_8.pdf.

Government of South Africa (1997): Water Services Act. http://www.dwaf.gov.za/Documents/Legislature/a108-97.pdf.

GreenCape (2017): Waste Economy: Market Intelligence Report. https://www.green-cape.co.za/assets/Uploads/GreenCape-Waste-MIR-2017-electronic-FINAL-v2.pdf.

Groundwork (2014): Slow Poison. Air Pollution, Public Health & Failing Governance. http://www.groundwork.org.za/specialreports/Slow%20Poison(e).pdf.

Infrastrucutrene.ws (2016): How Much Rubish South Africans Dump Each Day? http://www.infrastructurene.ws/2016/08/17/how-much-rubbish-south-africans-dump-each-day/.

Infrastructurene.ws (2017): SA on its Way Up the Waste Management Hierarchy. http://www.infrastructurene.ws/2017/04/19/sa-on-its-way-up-the-waste-management-hierarchy/.

[IRP] Integrated Resource Plan (2010): http://www.energy.gov.za/IRP/2010/IRP_2010.pdf.

Jennings, Gail (2017): Planning for Sustainable Urban Freight Movement. http://dtnac4dfluyw8.cloudfront.net/downloads/WWF_2017_OPCC_Sustainable_Urban_Freight.pdf.

[LCLUC] Land-Cover/Land-Use Change Program (n.d.): Dryland Degradation in South Africa. http://lcluc.umd.edu/hotspot/dryland-degradation-south-africa.

Makhafola, D. (06. 07 2018). S Africa wastewater facilities in disrepair. Abgerufen am 19. 07 2018 von Engineering News: http://www.engineeringnews.co.za/article/s-africa-wastewater-facilities-in-disrepair-2018-07-06

Mail & Guardian (2007): A Victory for Environmental Protection. https://mg.co.za/article/2007-03-16-a-victory-for-environmental-protection.

McDaid (2014): The Health Impact of Coal: The Responsibility that Coal-Fired Power Stations Bear for Ambient Air Quality Associated Health Impacts. http://www.groundwork.org.za/specialreports/groundWork%20The%20Health%20Impact%20of%20Coal%20final%2020%20May%202014.pdf.

McHale, M., Bunn, D., & Riddell, E. (21. 05 2018). Small, local solutions can crack water crisis: A South African Case Study. The Conversation .

Meadows, M.W. & Hoffman, M.T. (2003): The Nature, Extent and Cause of Land Degradation in South Africa: Legacy of the Past, Lessons for the Future. https://onlinelibrary.wiley.com/doi/pdf/10.1111/1475-4762.00100.

[NACA] National Association for Clean Air (n.d.). http://www.naca.org.za/.

Nkosi, Nhlanhla, Muzenda, Edison, Zvimba, John and Pilusa, Jefrey (2013): Current Waste Generation and Management Trends in South Africa: A Review. https://researchspace.csir.co.za/dspace/bitstream/handle/10204/6792/Zvimba1_2013.pdf?sequence=3&isAllowed=y.

[NWRS] National Water Resource Strategy (2013): Water for an Equitable and Sustainable Future. http://www.wrc.org.za/SiteCollectionDocuments/Acts%20for%20govenance%20page/DWS%20National%20Water%20Resources%20Strategy%202LinkClick.pdf.

Pereira, Taryn (n.d.). Climate Change Mitigation in the Water Sector or How to Reduce the Carbon Footprint of Water. http://www.emg.org.za/images/downloads/water_cl_ch/mitigation%20report.pdf.

Provincial Government Handbook (2019). https://provincialgovernment.co.za/.

Reuben, Aaron & Malik, Omar (2013): Troubling Trends for South Africa. http://archive.epi.yale.edu/case-study/troubling-trends-south-africa.

[SACN] South African Cities Network (2016): State of Water in Cities: Analysis of Water Resource and its Management in Cities. http://www.sacities.net/wp-content/uploads/2016/PDF/State-of-Water-in-Cities_FINAL-e-version_spreads.pdf.

SA Department of Environmental Affairs . (02. 09 2016). Department of Environmental Affairs. Abgerufen am 29. 05 2018 von State of the Environement: http://soer.deat.gov.za/newsDetailPage.aspx?m=66&amid=16320

Shoeman Law Inc. (14. 02 2018). Polity.

South Africa Habitat National Team (n.d.): National Report by the Republic of South Africa for Third United Nations Conference on Housing and Sustainable Urban Development. Habitat III. http://3.org/wp-content/uploads/South-Africa_1.pdf.

South Africa: Social Perspective of Environmental Issues (n.d.). http://blogs.nelson.wisc.edu/es112-301-southafrica/climate-change-2/agriculture/.

South African Government (2020): Structures and functions of the South African Government. https://www.gov.za/node/537988.

South African Government (n.d.): Constitution of the Republic of South Africa 1996. Schedule 4. Functional Areas of concurrent national and provincial legislative competence. https://www.gov.za/documents/constitution-republic-south-africa-1996-schedule-4-functional-areas-concurrent-national.

South Africa today. (17. 11 2017). Air Quality Plans in 3 of South Africa's Most Polluted Cities . South Africa Today , 2018 (05), S. 28.

South Africa Yearbook (2018/2019): Government Systems. https://www.gcis.gov.za/south-africa-yearbook-201819.

Sutherland, S. (25. 01 2018). Cape Town Crisis: How does a global city run out of water? .

[UNEP] United Nations Environment Programme (n.d.): Southern Africa. Actions Taken by Governments to Improve Air Quality. http://wedocs.unep.org/bitstream/handle/20.500.11822/20248/SouthernAfrica_report.pdf?sequence=1&isAllowed=y.

Water Resource Group (2018): Strategic Water Partners Network South Africa: Closing the Water Gap by 2030. http://www.2030wrg.org/wp-content/uploads/2014/08/South-Africa_Strategic-Water-Partners-Network-Brochure.pdf.

[WHO] World Health Organization (2016): WHO Global Urban Ambient Air Pollution Database. http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/.

Wills, Alf. Deputy Director General: International Cooperation. Department of Environmental Affairs (2010). http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/southafricacphaccord_app2.pdf.

Wright, C. (27. 09 2017). Air Quality & human Health in SA: translating the Research for Policy Practice. Abgerufen am 19. 07 2018 von SA Medical Research Council : http://webcache.googleusercontent.com/search?q=cache:CJeTz2uiZ1YJ:www.health.gov.za/index.php/shortcodes/2015-03-29-10-42-47/2015-04-30-08-29-27/2015-04-30-08-32-49%3Fdownload%3D2431:wright-ndoh-weh-26sep2017+&cd=5&hl=en&ct=clnk&gl=de&client=safari

Wright, C. Y. (26. 09 2017). Environment and Health Research Unit. Abgerufen am 28. 05 2018 von South African Medical Research Council : www.health.gov.za/index.php/shortcodes/2015.../2015-04-30-08-32-49?... 1 Cached

Indonesia

Abidin, H., Andreas, H., Gumilar, I., and Fukuda, Y. (2011): Land subsidence of Jakarta (Indonesia) and its relation to urban development. In: Natural Hazards 59(3).

[ADB] Asian Development Bank (2010): Indonesia Air Quality Profile. http://www.indiaenvironmentportal.org.in/files/Indonesia_Air_Quality_Profile_-_2010_Edition.pdf

[ADB] Asian Development Bank (2016): Indonesia Country Water Assessment. https://www.adb.org/documents/indonesia-country-water-assessment

Aditya, Rendy Bayu (2016): Toward water sensitive cities. http://www.thejakartapost.com/academia/2016/04/05/toward-water-sensitive-cities.html

Bakker, Karen & Kooy, Michelle (2012): Governance Failure and Conflict in Jakarta, Indonesia. In: Urban Water Conflicts, Bernard Barraqué (ed.), Taylor & Francis: Leiden.

[BAPPENAS] Ministry of National Development Planning (2016): Indonesia Biodiversity Strategy and Action Plan.

Brinkmann, Jan Jaap (2012): Jakarta Coastal Defence Strategy Study.

Bunnell, Tim et al. (2013): Urban Development in a Decentralized Indonesia: Two Success Stories? In: Pacific Affairs, 86, 4, pp. unknown. Available at: https://profile.nus.edu.sg/fass/geotgb/bunnell%20et%20al%20prepublication.pdf

[CAT] Climate Action Tracker (2018): Indonesia. https://climateactiontracker.org/countries/indonesia/pledges-and-targets/

[CAT] Climate Aciton Tracker (2019): Indonesia. https://climateactiontracker.org/countries/indonesia/.

[CBD] Convention on Biological Diversity (n.d.): Indonesia – Country Profile. https://www.cbd.int/countries/profile/default.shtml?country=id#facts

CIFOR (2015): Forest and land-use governance in a decentralized Indonesia - A legal and policy review. http://www.cifor.org/publications/pdf_files/OccPapers/OP-132.pdf

Chaussard, Estelle (2012): Sinking cities in Indonesia: ALOS PALSAR detects rapid subsidence due to groundwater and gas extraction. In: Remote Sensing of Environment 128, 2013, pp. 150-161.

Climate Central (2019): Report: Flooded Future: Global vulnerability to sea level rise worse than previously understood. https://www.climatecentral.org/news/report-flooded-future-global-vulnerability-to-sea-level-rise-worse-than-previously-understood.

Cochrane, Joe (2015): As Indonesia Prospers, Air Pollution Takes Toll. In: New York Times Online: https://www.nytimes.com/2015/09/27/world/asia/as-indonesia-prospers-air-pollution-takes-toll.html

Conservation International (2017): What are the issues? http://www.conservation.org/where/Pages/Indonesia.aspx

Ekonid (2016): Indonesiens Abfallwirtschaft 2016 – Eine Untersuchung anhand von sechs indonesischen Städten. http://indonesien.ahk.de/fileadmin/ahk_indonesien/Business_Delegations/BMUB_Waste_Management/BMUB_Waste_Management_in_Indonesien_2016_FINAL.pdf

[GBPN] Green Buildings Performance Network (n.d.): Country Information Indonesia. http://www.gbpn.org/beet-3/country-infosheets/indonesia#Energy%20Performance%20Certificates

[GIZ] Gesellschaft für Internationale Zusammenarbeit (2010): Program Transportasi Perkotaan Berkelanjutan - Indonesia/ Sustainable Urban Transport – Programme Indonesia. http://transferproject.org/wp-content/uploads/2015/05/SUTRI_NAMA_Concept-Document_Indonesian-version.pdf

[GIZ] Gesellschaft für Internationale Zusammenarbeit (2018): Promoting Bus Systems in Indonesian Cities. https://www.giz.de/en/worldwide/42927.html

Government of Indonesia (2016): First Nationally Determined Contribution – Republic of Indonesia. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwiYn4Lx1OnaAhVC3iwKHTrWDq8QFggoMAA&url=http%3A%2F%2Fwww4.unfccc.int%2Fndcregistry%2FPublishedDocuments%2FIndonesia%2520First%2FFirst%2520NDC%2520Indonesia_submitted%2520to%2520UNFCCC%2520Set_November%2520%25202016.pdf&usg=AOvVaw0AldCR8FO9812D0VKVCsPj

Greenpeace (2017): Jakarta's Silent Killer. http://m.greenpeace.org/seasia/PageFiles/766576/Jakarta%27s%20Silent%20Killer%20Report%20-%20Oct%2024%202017.pdf

Hamzah, Hidayah (2017): Without Forests, Jakarta's Water Situation Worsens. http://www.wri.org/blog/2017/07/without-forests-jakartas-water-situation-worsens

Heryanto, Devina (2018): Jakarta's air pollution worse than Bangkok, better than Manila: WHO. http://www.thejakartapost.com/news/2018/05/03/jakartas-air-pollution-worse-than-bangkok-better-than-manila-who-1525325966.html

Handayeni, Ketut Dewi Martha Erli (2013): Best Practice: Lesson Learned for GHG Mitigation on Transportation Sector in Surabaya City, Indonesia. In: Procedia – Social and Behavioral Science, 135, 2014, pp. 152-158.

Hodal, Kate (2011): Living off the landfill: Indonesia's resident scavengers. https://www.theguardian.com/world/2011/sep/27/indonesia-waste-tip-scavengers

[ICCT & DieselNet] International Council on Clean Transportation & DieselNet (2018): Regions – Indonesia. https://www.transportpolicy.net/region/asia/indonesia/

[IEA] International Energy Agency (2015): Indonesia. https://www.iea.org/policiesandmeasures/energyefficiency/?country=Indonesia

[IISD] International Institute for Sustainable Development (2020): Removing subsidies for gasoline and diesel consumption in Indonesia. https://www.iisd.org/system/files/publications/stories-g20-indonesia-en.pdf.

Indonesia Habitat National Team (2016): Indonesia National Report for Habitat III. http://habitat3.org/wp-content/uploads/National-Report_INDONESIA.pdf

Jakarta Post News Desk (2017): Car Free Day ineffective in reducing air pollution: Committee. http://www.thejakartapost.com/news/2017/09/23/car-free-day-ineffective-in-reducing-air-pollution-committee.html

Jong, Hans Nicholas (2015): Energy sector biggest emissions emitter. http://www.thejakartapost.com/news/2015/07/28/energy-sector-biggest-emissions-emitter.html

Kasdiono, Eddy (2014): Sustainable buildings good for today and future generations. http://www.thejakartapost.com/news/2014/11/21/sustainable-buildings-good-today-and-future-generations.html

[KfW] Kreditanstalt für Wiederaufbau (2017): Emissionen und Städte – Projektinformationen. https://www.kfw-entwicklungsbank.de/PDF/Entwicklungsfinanzierung/Länder-und-Programme/Asien/Projekt-Indonesien-Klima-2015.pdf

Kooy, Michelle & Furlong, Kathryn (2018):Why the rich in Jakarta have better access to water than the poor. http://www.thejakartapost.com/academia/2018/03/19/why-the-rich-in-jakarta-have-better-access-to-water-than-the-poor.html

Kurniati, Ayu & Nitivattananon, Vilas (2016): Factors Influencing Urban Heat Island in Surabaya, Indonesia. https://kundoc.com/pdf-factors-influencing-urban-heat-island-in-surabaya-indonesia-.html

Kusumwijaya, Marco (2016): Jakarta at 30 million: my city is choking and sinking – it needs a new Plan B. https://www.theguardian.com/cities/2016/nov/21/jakarta-indonesia-30-million-sinking-future

[LoC] Library of Congress (2017): Indonesia: New Regulation on Emission Levels. http://www.loc.gov/law/foreign-news/article/indonesia-new-regulation-on-emission-levels/

[MLIT] Japanese Ministry of Land, Infrastructure, Transport and Tourism (n.d.): Indonesia – Country Profile. http://www.mlit.go.jp/kokudokeikaku/international/spw/general/indonesia/index_e.html

[MoEF] Ministry of Environment and Forestry (2015): The Fifth National Report to the Convention on Biological Diversity. https://www.cbd.int/doc/world/id/id-nr-05-en.pdf

[MoEF] Ministry of Environment and Forestry (2015): Indonesia – First Biannual Update Report (BUR). https://unfccc.int/files/national_reports/non-annex_i_parties/biennial_update_reports/application/pdf/idnbur1.pdf

Mersmann, Florian et al. (2017): Implementation of Nationally Determined Contributions. https://epub.wupperinst.org/frontdoor/deliver/index/docId/6894/file/6894_NDCs_Indonesia.pdf

Mulyana, Wahyu et al. (2013): Urbanisation,Demographics and Adaptation to Climate Change in Semarang, Indonesia. https://www.unfpa.org/sites/default/files/resource-pdf/10632IIED.pdf

Nasution, Achmad Delianur & Zahrah, Wahyuni (2014): Community Perception on Public Open Space and Quality of Life in Medan, Indonesia. https://ac.els-cdn.com/S1877042814055335/1-s2.0-S1877042814055335-main.pdf?_tid=f75366a5-3035-4b3a-8047-ebaada6a122a&acdnat=1525426233_fac53e989e9a3abdb9fd41ea31bb7ddb

[OECD] Organisation for Economic Cooperation and Development (2016): Green Growth in Bandung, Indonesia. OECD Publishing: Paris.

Pacific Media Centre (2016): Indonesia on fire, cross-boundary public health hazards. https://asiapacificreport.nz/2016/05/06/indonesia-on-fire-cross-boundary-public-health-hazards/

Presatyo, Sandi et al. (2016): Model of Noise Propagation in Urban Area - A Case Study in Jakarta. http://www.oidaijsd.com/Files/09-02-03.pdf

Regulation on the Management of Rainwater on Buildings and their plots on land No. 11/PRT/M/2014. http://extwprlegs1.fao.org/docs/pdf/ins148938.pdf.

Regulation of Minister of Home Affairs No. 1/2007 on Green Open Space in Cities. http://extwprlegs1.fao.org/docs/pdf/ins74544.pdf.

Rukama, Deden (2009): Climate Change and Urban Development.
http://indonesiaurbanstudies.blogspot.de/search?q=Climate+Change+and+Urban+Development

Rukama, Deden (2009b): Restoring Green Areas in Jakarta.
http://indonesiaurbanstudies.blogspot.de/2009/11/restoring-green-areas-in-jakarta.html

Rukama, Deden (2015): The Change and Transformation of Indonesian Spatial Planning.
http://indonesiaurbanstudies.blogspot.de/2015/03/the-change-and-transformation-of.html

Rukama, Deden (2016): Problems and Challenges in Jakarta Caused by Rapid Urbanization.
http://indonesiaurbanstudies.blogspot.de/2016/11/problems-and-challenges-in-jakarta_53.html

Saputra, Erlis et al. (2017): Fighting the Ignorance: Public Authorities' and Land Users' Responses to Land Subsidence in Indonesia. In: American Journal of Climate Change, 06, 2017, pp. unknown. Available at: http://file.scirp.org/Html/1-2360449_73975.htm

Sondakh, Daniel et al. (2014): Analysis of Noise Pollution on Airport Environment (Case study of International Airport of Sam Ratulangi Manado, Indonesia). In: International Journal of Engineering Inventions, 4, 2014, pp. 13-19. Available at: http://www.ijeijournal.com/papers/Vol.4-Iss.2/C04021319.pdf

Sherwell, Philip (2016): $40bn to save Jakarta: the story of the Great Garuda.
https://www.theguardian.com/cities/2016/nov/22/jakarta-great-garuda-seawall-sinking

Soma, Tammara (2014): A Month a Blessing and Food Waste.
http://www.thejakartapost.com/news/2014/07/02/a-month-blessing-and-food-waste.html

[SPARK] Strategic Planning and Action to Strengthen Climate Resilience of Rural Communities (2018): https://www.id.undp.org/content/indonesia/en/home/operations/projects/environment_and_energy/strategic-planning-and-action-to-strengthen-climate-resilience--.html.

Süddeutsche Zeitung Online (2016): Gewaltige Mauer im Meer soll Jakarta Retten. https://sueddeutsche.de

The Jakarta Post / Parry, David (2014): Your letters: Flooding in Jakarta – The facts.
http://www.thejakartapost.com/news/2014/01/28/your-letters-flooding-jakarta-facts.html (letter to editors)

[UBA] Umweltbundesamt (2015): Lärmwirkung. https://www.umweltbundesamt.de/themen/verkehr-laerm/laermwirkungen#textpart-1

[UNDP] United Nations Development Programme (2018): UNDP supporting Indonesia in drive for climate-resilient farming communities. https://www.adaptation-undp.org/undp-supporting-indonesia-drive-climate-resilient-farming-communities.

[UNEP] United Nations Environment Programme (2015): Air Quality Policies.
https://wedocs.unep.org/bitstream/handle/20.500.11822/17217/Indonesia.pdf?sequence=1&isAllowed=y

[UNEP] UNDP (2016): Indonesia launches national blueprintto protect its biodiversity.
https://www.id.undp.org/content/indonesia/en/home/presscenter/pressreleases/2016/01/21/indonesia-launches-national-blueprint-to-protect-its-biodiversity.html.

Uletika, N.S. (2016): Noise Reduction in Industrial Environment: Case Study in Cement Factory Cilacap, Indonesia. In: International Journal of Innovation and Applied Studies, 18, 2016, pp. 388-394. Available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=2ahUKEwjn4oPe8drcAhVILVAKHbpUCo0QFjAAegQIARAC&url=http%3A%2F%2Fwww.issr-journals.org%2Flinks%2Fpapers.php%3Fjournal%3Dijias%26application%3Dpdf%26article%3DIJIAS-16-139-01&usg=AOvVaw2Ikh7D32xtxyzGV5v7JqIS

[US EPA] United States Environmental Protection Agency (2017): The Ozone Problem.
https://www3.epa.gov/region1/airquality/oz_prob.html

The Guardian (2009): Coral reefs around the world.
https://www.theguardian.com/environment/interactive/2009/sep/02/coral-world-interactive

Vidal, John (2014a): Indonesia's forest fires feed 'brown cloud' of pollution choking Asia's cities. The Guardian Online. https://www.theguardian.com/environment/2014/mar/23/indonesia-forest-fires-pollution-asia

Vidal, John (2014b): Smelly, contaminated, full of disease: the world's open dumps are growing.
https://www.theguardian.com/global-development/2014/oct/06/smelly-contaminated-disease-worlds-open-dumps

[WHO] World Health Organization (2018): Environment and Health – Noise.
http://www.euro.who.int/en/health-topics/environment-and-health/noise

Wijaya, Callistasia Anggun (2016): Jakarta seeing results with cleaner rivers.
http://www.thejakartapost.com/news/2016/05/23/jakarta-seeing-results-with-cleaner-rivers.html

World Bank (2013): Indonesia – Toward Universal Access to Clean Cooking.
http://documents.worldbank.org/curated/en/105441468044144806/pdf/792790ESW0P1290ox0377371B00PUBLIC00.pdf

WorldBank (2016): Urban Population (% of total).
https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=BR. Aufgerufen am 30.04.2018.

World Bank (2017): Project Information Document - Improvement of Solid Waste Management to Support Regional and Metropolitan Cities.
http://documents.worldbank.org/curated/en/640491496386470384/pdf/PIDISDS-CON-Print-P157245-06-02-2017-1496386463379.pdf

[WWF] World Wildlife Fund (2018a): Mitigation.
https://www.wwf.or.id/en/about_wwf/whatwedo/climate/oursolutions/mitigation/

[WWF] World Wildlife Fund (2018b): Freshwater - Challenges.
https://www.wwf.id/en/about_wwf/whatwedo/freshwater/challenges/

[WWF] World Wildlife Fund (2018c): M3-South East Sulawesi – Natural Resources Management Campaign.
https://www.wwf.or.id/en/about_wwf/whatwedo/marine_species/how_we_work/campaign/m3_campaign/m3_south_east_sulawesi/

Yudha, Satya (2017): Air Pollution and its Implications for Indonesia.
http://pubdocs.worldbank.org/en/183201496935944434/200417-AirQualityAsia-Air-Pollution.pdf

Case Study: Belo Horizonte, Brazil

ABES. (2013). Afluentes da Lagoa da Pampulha têm papel fundamental na poluição do espelho d'água. Retrieved 29 March 2019, from Associação Brasileira de Engenharia Sanitaria e Ambiental - Secão Minas Gerais website: http://www.abes-mg.org.br/visualizacao-de-clipping/ler/3955/afluentes-da-lagoa-da-pampulha-tem-papel-fundamental-na-poluicao-do-espelho-d-agua

Azevedo, A. L. (2019, February 3). Dano ambiental em Brumadinho ameaça centenas de espécies. Retrieved 2 April 2019, from O Globo website: https://oglobo.globo.com/brasil/dano-ambiental-em-brumadinho-ameaca-centenas-de-especies-23424033

BHTrans. (2017). Plano Diretor de Mobilidade Urbana de Belo Horizonte - PlanMob-BH 2030. Relatório Síntese. Belo Horizonte: BHTrans.

BHTrans. (2018). PlanMobBH 2030. Status Maio/18. Presented at the Belo Horizonte. Belo Horizonte.

BHTrans, & ObsMob-BH. (2019). BALANÇO ANUAL DA MOBILIDADE URBANA DE BELO HORIZONTE - 2018 (ano-base 2017). Retrieved from Prefeitura BH website: https://prefeitura.pbh.gov.br/sites/default/files/estrutura-

de-
governo/bhtrans/2019/documentos/Balanço%20anual%20da%20mobilidade%20urbana%20de%20Belo%20Horizonte%202018%20(ano%20base%202017).pdf

Campos, R. (2017, December 12). Especialistas avaliam os principais problemas de Belo Horizonte. Retrieved 14 March 2019, from Revista Encontro website: https://www.revistaencontro.com.br/canal/revista/2017/12/especialistas-avaliam-os-principais-problemas-de-belo-horizonte.html

CEPAL. (2019). Brasil - Sistema político e eleitoral [Text]. Retrieved 28 May 2019, from Observatório de Igualdade de Gênero da América Latina e do Caribe website: https://oig.cepal.org/pt/paises/7/system

Globo. (2019, December 3). Sobe para 201 o número de mortos identificados no desastre da Vale em Brumadinho. Retrieved2 April 2019, from G1 Minas Gerais website: https://g1.globo.com/mg/minas-gerais/noticia/2019/03/12/sobe-para-201-o-numero-de-mortes-confirmadas-no-desastre-da-vale-em-brumadinho.ghtml

Gouveia, N., Junger, W., Lins, J. de F., & Freitas, C. (2018). Poluição do ar e impactos na saúde na Região Metropolitana de Belo Horizonte – Minas Gerais. Ciência & Saúde Coletiva. Retrieved from http://www.cienciaesaudecoletiva.com.br/artigos/poluicao-do-ar-e-impactos-na-saude-na-regiao-metropolitana-de-belo-horizonte-minas-gerais/16710?id=16710

IBGE. (2019, March 14). IBGE | Brasil em Síntese | Minas Gerais | Belo Horizonte | Panorama. Retrieved 14 March 2019, from Instituto Brasileiro de Geografía e Estatísitca (IBGE) website: https://cidades.ibge.gov.br/brasil/mg/belo-horizonte/panorama

Lopes, V. (2016, June 9). Prefeitura de Belo Horizonte revê plano estratégico para 2030. Retrieved 12 June 2019, from Estado de Minas website: https://www.em.com.br/app/noticia/gerais/2016/06/09/interna_gerais,770847/prefeitura-de-belo-horizonte-reve-plano-estrategico-para-2030.shtml

Meio Ambiente. (2018, January 19). Comitê de Mudanças Climáticas | Prefeitura de Belo Horizonte. Retrieved 14 March 2019, from Prefeitura Belo Horizonte website: /meio-ambiente/comite-de-mudancas-climaticas

Mendonça, H. (2016, November 5). Lo que el barro se llevó. El País. Retrieved from https://elpais.com/internacional/2016/11/05/actualidad/1478372852_648384.html

Minas Guide. (2018). Economía de Minas Gerais por sectores productivos. Retrieved 19 March 2019, from Minas Gerais Business Guide website: https://www.minasguide.com/es/sectores-productivos/

Oliveira, J. C. (2019, February 27). Danos ambientais do desastre em Brumadinho são detalhados em comissão. Retrieved 2 April 2019, from Câmara dos Deputados website: https://www2.camara.leg.br/camaranoticias/noticias/MEIO-AMBIENTE/573031-DANOS-AMBIENTAIS-DO-DESASTRE-EM-BRUMADINHO-SAO-DETALHADOS-EM- COMISSAO.html

OPS. (2017, October 17). BH 2030: Um esboço do futuro. Retrieved 12 June 2019, from Observatório Político Social (OPS) website: http://opsn.com.br/bh-2030-um-esboco-do-futuro/

Parreiras, M. (2015, July 26). Desmatamento avança pelos arredores de BH. Retrieved 11 June 2019, from Estado de Minas website: https://www.em.com.br/app/noticia/gerais/2015/07/26/interna_gerais,672275/devastacao-e-impunidade.shtml

Prefeitura BH. (1985, April 12). Lei no 4.253 de 04/12/1985 - Municipal - Belo Horizonte. Retrieved 3 June 2019, from LegisWeb website: https://www.legisweb.com.br/legislacao/?id=172544

Prefeitura BH. (2012). Lei Ordinária 10175 2011 de Belo Horizonte MG. POLÍTICA MUNICIPAL DE MITIGAÇÃO DOS EFEITOS DA MUDANÇA CLIMÁTICA. Retrieved 14 June 2019, from Leis Municipais website: https://leismunicipais.com.br/a/mg/b/belo-horizonte/lei-ordinaria/2011/1018/10175/lei-ordinaria-n-10175-2011-institui-a-politica-municipal-de-mitigacao-dos-efeitos-da-mudanca-climatica

Prefeitura BH. (2015a). 3° Inventário de Emissão de Gases de Efeito Estufa. Atualização 2011/2012/2013. Período de Referência: 2000 a 2013. Relatório Técnico Final. Belo Horizonte: Prefeitura BH.

Prefeitura BH. (2015b). Belo Horizonte, Cidade Sustentável. Belo Horizonte: Prefeitura BH.

Prefeitura BH. (2016). Plano Estratégico BH 2030. BH no Rumo Certo [Plan]. Retrieved from Prefeitura BH website: https://www.marciolacerda.com.br/wp-content/uploads/plano-bh2030/PB-0023-15H-RELATORIO-BH2030_23x31cm_26-04_AFS.pdf

Prefeitura BH. (2017a, March 30). Prefeitura lança plano de gestão de resíduos da capital. Retrieved 13 June 2019, from Prefeitura de Belo Horizonte website: /noticias/prefeitura-lanca-plano-de-gestao-de-residuos-da-capital

Prefeitura BH. (2017b, November 24). BH terá Plano Municipal de Adaptação e Resiliência. Retrieved 14 March 2019, from Prefeitura de Belo Horizonte website: /noticias/bh-tera-plano-municipal-de-adaptacao-e-resiliencia

Prefeitura BH. (2018a). Programa Estratégico Belo Horizonte, Cidade Inteligente. Presented at the Belo Horizonte. Belo Horizonte.

Prefeitura BH. (2018b, April 4). Coleta Seletiva. Retrieved from Prefeitura de Belo Horizonte website: /slu/informacoes/coleta-seletiva

Prefeitura BH. (2018c, April 7). INTERCAT-Bio | Prefeitura de Belo Horizonte. Retrieved 14 June 2019, from Prefeitura Belo Horizonte website: /meio-ambiente/intercat-bio

Prefeitura BH. (2019a, March 29). Proposta - Novo Plano Diretor | Prefeitura de Belo Horizonte. Retrieved 20 May 2019, from Prefeitura Belo Horizonte website: /politica-urbana/planejamento-urbano/plano-diretor/proposta

Prefeitura BH. (2019b, May 28). Números da Limpeza Urbana | Prefeitura de Belo Horizonte. Retrieved 14 June2019, from Prefeitura Belo Horizonte website: /slu/informacoes/numeros-limpeza-urbana

Prefeitura BH, WayCarbon, & Konrad Adenauer Stiftung. (2016). ANÁLISE DE VULNERABILIDADE ÀS MUDANÇAS CLIMÁT ICAS DO MUNICÍPIO DE BELO HORIZONTE - RESUMO PARA OS TOMADORES DE DECISÃO. Retrieved from Prefeitura BH website: https://www.kas.de/c/document_library/get_file?uuid=81e6462d-a9af-ae09-9817-b797afbf41ad&groupId=252038

Secretaria Municipal de Governo BH (2013): . Plano Diretor de Mobilidade Urbana de Belo Horizonte - PlanMob-BH, Pub. L. No. DECRETO No 15.317. http://portal6.pbh.gov.br/dom/iniciaEdicao.do?method=DetalheArtigo&pk=1106431

WRI Brasil. (2018, June 21). Qualidade do ar no Brasil: o que está em jogo na mudança dos padrões. WRI Brasil. https://wribrasil.org.br/pt/blog/2018/06/qualidade-do-ar-no-brasil-o-que-esta-em-jogo-na-mudanca-dos-padroes

WWF Brazil. (2014). Brasil e as mudanças climáticas | WWF Brasil. WWF Brazil. https://www.wwf.org.br/natureza_brasileira/reducao_de_impactos2/clima/politicas_de_clima/brasil_mudancas_climaticas/

Case Study: Moscow, Russia

City of Moscow (2019): An overview of the waste management legislation and regulation. Available at: https://investinfra.ru/regionalnye-operatory/gorod-moskva.html.

Correlation between ambient air standards and maximum allowable concentration values. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5397445/.

Deloitte City Mobility Index (n.d.): Moscow: Mobility Analysis. Available at https://www2.deloitte.com/content/dam/insights/us/articles/4331_Deloitte-City-Mobility-Index/Moscow_GlobalCityMobility_WEB.pdf.

Domingo, Irena (2016): Moscow's Troika Card: paying all public transport costs with one card. Russiau. Available at https://russiau.com/moscow-troika-card-public-transport/.

Federal and Moscow city legislation in the area of water management. Available at http://www.mosvodokanal.ru/about/law/.Government Decree (2019): Decree on Russia's participation in the Paris climate agreement. http://government.ru/docs/37917/.

Federal Service on Surveillance for Consumer Rights Protection and Human Well-Being and the Chief Sanitary Doctor of Russia (2018): List of maximum permissible concentration values for outdoor air as adopted in January, 2018. Available at:http://04.rospotrebnadzor.ru/dock/postan/postanovlenie_fs_165_22_12_2017.pdf or http://www.dpioos.ru/eco/ru/specifications.

Gasho E., Guseva T., Stepanova M., Malkov A., Lomakina I. Developing climate change strategy for Moscow. In: Proceedings of SGEM Vienna GREEN 2017. Vienna, 2017. Vol. 17. Issue 43. pp. 357-364

Governmental Decree of the City of Moscow "New Ecological Policy till 2030" (2014, amended in 2016). Available at: http://docs.cntd.ru/document/537958009.

Government of Moscow (2019): The new above-ground metro: why we need Moscow Central Diameters. https://www.mos.ru/en/city/projects/diametries/.

Government of Moscow (2019a): Rates for bike rental in 2019 will remain unchanged. https://www.mos.ru/mayor/themes/2299/5607050/.

Government of Moscow (2019b): This is an electric bus. What you need to know about environmentally-friendly city transport. https://www.mos.ru/news/item/64207073/.

Government of Moscow (n.d.): Rates and payment rules for parking in Moscow. https://parking.mos.ru/new/ .

Kodukula, Santhosh; Rudolph, Frederic; Jansen, Ulrich; Amon, Eva (2018): Living. Moving. Breathing. Wuppertal: Wuppertal Institute. Available at https://www.greenpeace.de/sites/www.greenpeace.de/files/publications/living.moving.breathing.20180604.pdf

Kolik, A., A. Radziwill and N. Turdyeva (2015): Improving Transport Infrastructure in Russia. OECD Economics Department Working Papers, No. 1193, OECD Publishing. Available at http://dx.doi.org/10.1787/5js4hmcs3mxp-en.

[MIC] Mobility in Chain (n.d.): Moscow Green Ring – Phase one. Available at http://www.michain.com/en/works/moscow-green-ring-phase-one/.

[MIC] Mobility in Chain (2014): Pedestrian and Bicycle Master Plan Moscow 2020. Available at http://www.michain.com/en/works/pedestrian-and-bicycle-master-plan-moscow-2020/.

Moscow City Building Code. Available at: http://mosopen.ru/documents/main/gradostroitelniy-kodeks-moskvi/g1.

Moscow city legislation in the area of healthcare. Available at https://mosgorzdrav.ru/ru-RU/citizens/independentevaluation/independent_evaluation_npa.html.

Moscow city legislation in the area of transport and transport infrastructure. Available at https://www.mos.ru/dt/documents/proekty-postanovlenii-i-rasporiazhenii-pravitelstva-moskvy/?page=4.

Moscow city legislation on protection of population and the territory of the city from natural and technological disasters. Available https://moscow.mchs.ru/document/36028.

Moscow city program on environmental protection (2011-2016). Available https://www.mos.ru/upload/documents/discussions/Poslednyaya_prezentatsiya_Programmy.pdf.

Moscow Department for Nature Use and Environmental Protection (2017): http://www.dpioos.ru/eco/ru/noise

Moscow Department for Nature Use and Environment (2019): Report on the Condition of Environment in Moscow in 2018. https://www.mos.ru/eco/documents/doklady/view/227443220/.

Moscow Housing Renovation Program. Available at: https://www.mos.ru/programmarenovacii.pdf.

Mosecom (n.d.): Moscow air quality measurements, map of pollution, data in real-time Available at http://mosecom.ru/air-quality/.

Movmi (2018): Shared Mobility by Region. Available at http://movmi.net/russia-shared-mobility-region/.

Report on the state of environment in Moscow in 2018 (published in early July, 2019). Available at: https://www.mos.ru/upload/documents/files/8725/DOKLAD_2018itog.pdf.

[PWC] PricewaterhouseCoopers (2018): Russian automotive market H1 2018 results and outlook. Special Review: Car sharing in Russia. Available at https://www.pwc.ru/en/automotive/assets/auto-press-briefing-1h-2018-24-09-18-eng.pdf.

[PWC] PricewaterhouseCoopers (2018a): The future of the automotive industry. Available at https://investinrussia.com/data/files/sectors/autotech-survey-2018-eng.pdf.

Tomtom Traffic Index (2018). Available at https://www.tomtom.com/en_gb/traffic-index/ranking/.

[UITP] Union Internationale des Transports Publics (2016): Moscow (Re)Opens its Central Railway Line. Available at https://www.uitp.org/news/moscow-reopens-its-central-circle-railway-line.

[UNECE] United Nations Economic Commission of Europe (n.d.). Cycling Programs in Moscow and other Russian Cities. Available at https://www.unece.org/fileadmin/DAM/trans/doc/2017/wp5/WP5_30th_session_Ms_Maltseva_Part1.pdf.

Case Study: Beijing, China

Beijing Government. (2013). Five-Year Clean Air Action Plan (2013-2017) (in Chinese). https://www.bjxnyqc.org/news/detail/191

Beijing Government (2015). Beijing Water Pollution Control Action Plan http://www.bjmtg.gov.cn/bjmtg/ztzl/jbdc/201904/1002953.shtml

Beijing Government (2016). Beijing 13th Five Year Plan of Water Management. http://invest.beijing.gov.cn/xxpt/fzgh/bjsgh/201912/t20191206_907945.html

Beijing Government. (2016). 13th FYP of energy efficiency and climate action (in Chinese). http://www.ccchina.org.cn/nDetail.aspx?newsId=63102&TId=60

Beijing Government. (2017a). Beijing 13th Five Year Plan of Environmental Protection (in Chinese). http://www.beijing.gov.cn/zhengce/wenjian/192/33/401/2751/1242131/142701/index.html

Beijing Government. (2017b). Most Stringent Water Resource Management (in Chinese). http://www.beijing.gov.cn/zhengce/zfwj/25/26/421256/12318/index.html

Beijing Government. (2018a). Reflection on 2017 and work plan for 2018 (in Chinese). http://www.beijing.gov.cn/zfxxgk/110029/gzjh32/2018-09/27/content_0ceae56319ad4bd0a347765a27dcf392.shtml

Beijing Government. (2018b). Three-Year Action Plan for Blue Sky (in Chinese). http://www.beijing.gov.cn/zhengce/wenjian/192/33/50/438650/1565680/index.html

Beijing News. (2017). Beijing Municipal Environmental Protection Bureau: Beijing's atmospheric management investment exceeded 30 billion in the past two years (in Chinese). http://www.xinhuanet.com//2017-12/13/c_1122101118.htm

Beijing News. (2018). Per capital GDP of Beijing first time exceeded 20000 USD (in Chinese). http://www.xinhuanet.com/fortune/2018-12/25/c_1123898917.htm

Beijing Youth (2020). 485 groundwater monitoring well will be started next year (in Chinese). http://beijing.qianlong.com/2019/1218/3467162.shtml

Biao, Z. (2011). The Climate Change, Water Crisis and Forest Ecosystem Services in Beijing, China. INTECH Open Access Publisher.

Birtles, B. (2018). Beijing churns out 25,000 tons of rubbish every day — here's how it deals with its waste crisis. ABC. https://www.abc.net.au/news/2018-08-07/how-beijing-deals-with-waste-crisis/10078026

BJ NEWS. (2018). Water saving in Beijing (in Chinese). http://www.bjnews.com.cn/feature/2018/05/19/487566.html

Boren, Z. (2017). Mapped: Nearly half of China's provinces have failed to clean up their water. Greenpeace. https://unearthed.greenpeace.org/2017/06/01/china-water-quality-data-shanghai-beijing/

C40. (n.a.). C40 China Buildings Programme: Launch Report. C40Cities & Berkley Lab. https://www.c40.org/researches/constructing-a-new-low-carbon-future-china

Cheng, J., Su, J.P., Cui, T., et al. (2019). Dominant role of emission reduction in PM2.5 air quality improvement in Beijing during 2013–2017: a model-based decomposition analysis., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp- 2018-1145-RC1, 2019

Central People's Government of the P.R.C (2013a). Air Pollution Prevention and Control Action Plan(in Chinese). http://www.gov.cn/zwgk/2013-09/12/content_2486773.htm

Central People's Government of the P.R.C (2013b): the Views of the State Council on Applying the Strictest Water resources Control System(in Chinese). http://www.gov.cn/zwgk/2013-09/12/content_2486773.htm

City Housing and Urban-Rural Development Committee. (2016). Notice on Printing and Distributing the Beijing Municipal Action Plan for Promoting the Development of Ultra-low Energy Buildings (2016-2018) (in Chinese). http://www.bjjs.gov.cn/bjjs/xxgk/qtwj/gcjsltz/396931/index.shtml

GOV. (2014). Beijing's water tariff reform (in Chinese). http://www.gov.cn/xinwen/2014-06/17/content_2702437.htm

GOV. (2016). Beijing: promoting waste sorting (in Chinese). http://www.gov.cn/xinwen/2016-09/15/content_5108666.htm

GOV. (2018a). Beijing plans to arrange 19.01 billion yuan to control air pollution in 2018 (in Chinese). http://www.gov.cn/xinwen/2018-01/26/content_5261062.htm

GOV. (2018b). The launch of water resource tax in Beijing (in Chinese).

International Platform of City Carbon Peak. (2018). Actions for achieving carbon peak in China (in Chinese). http://www.wwfchina.org/content/press/publication/2018/中国城市低碳与达峰告%20CH%20small%20size%201128.pdf

Jinran, J. (2016): Report reveals Beijing to be the largest producer of domestic waste. http://www.chinadaily.com.cn/china/2016-11/22/content_27458743.htm

Kostka, G. (2014). Barriers to the Implementation of Environmental Policies at the Local Level in China. Policy Research Working Papers. doi:10.1596/1813-9450-7016

Lin, M., et al. (2017): "Heavy Metal Contamination in Green Space Soils of Beijing, China." Acta Agriculturae Scandinavica, Section B — Soil & Plant Science, vol. 68, no. 4, 2017, pp. 291–300., doi:10.1080/09064710.2017.1395474.

Liu, T. et al. (2015). Urban household solid waste generation and collection in Beijing, China. Resources, Conservation and Recycling, 104-A, 31-37, doi: 10.1016/j.resconrec.2015.09.004

Liu, Z. and Cai, B. (2018). High-resolution Emission Data for Chinese Cities.Belfer Center for Science and International Affairs, Cambridge, Mass: Harvard University.

NDRC (2016). 13th Five Year Plan of urban wastewater treatment and water reclamation infrastructure(in Chinese). https://www.ndrc.gov.cn/xxgk/zcfb/ghwb/201701/t20170122_962224.html

People (2018): The establishment of the leader group of regional air pollution prevention and control. http://env.people.com.cn/n1/2018/0711/c1010-30141394.html

People Daily (2018). Beijing implements most Stringent Water Resource Management (in Chinese). http://energy.people.com.cn/n1/2018/0324/c71661-29886514.html

Pla, M. (2015). Municipal Solid Waste Management in Beijing. http://www.wiego.org/sites/default/files/resources/files/Pla-Solid-Waste-Management-China.pdf

Ritter, K, (2018). Water-stressed Beijing exhausts its options. Circle of Blue. https://www.circleofblue.org/2018/water-management/infrastructure/water-stressed-beijing-exhausts-its-options/

State Council. (2013). Action Plan for Air Pollution Prevention and Control (in Chinese). http://www.gov.cn/zwgk/2013-09/12/content_2486773.htm

The Economist. (2017): The most neglected threat to public health in China is toxic soil. https://www.economist.com/briefing/2017/06/08/the-most-neglected-threat-to-public-health-in-china-is-toxic-soil

UN Environment. (2019). A Review of 20 Years' Air Pollution Control in Beijing. United Nations Environment Programme, Nairobi, Kenya

Wang, J. et al. (2015). Beijing's Water Resources: Challenges and Solutions. Journal of the American Water Resources Association. doi: : 10.1111/1752-1688.12315

Yu, H., Pan, S., Tang, B., Mi, Z., Zhang, Y., & Wei, Y. (2014). Urban energy consumption and CO2 emissions in Beijing: Current and future. Energy Efficiency, 8(3), 527-543. doi:10.1007/s12053-014-9305-3

Case Study: Kochi, India

CPCB. (22. February 2018). CPCB Introduction. Abgerufen am 31. May 2018 von Central Pollution Control Board: http://cpcb.nic.in/Introduction/

CPCB. (2010). Kerala State Pollution Control Board: Action Plan for Greater Kochi Area. Abgerufen am 20. February 2019 von Central Pollution Control Board, Ministry of Environment, Forest and Climate Change, Government of India: http://cpcb.nic.in/displaypdf.php?id=Ri1Lb2NoaS5wZGY=

Deccan Chronicle. (09. December 2017). Kochi to take on air pollution. Abgerufen am 24. March 2019 von https://www.deccanchronicle.com/nation/in-other-news/091217/kochi-to-take-on-air-pollution.html

Deccan Chronicle. (25. November 2016). Kochi unaware of noise pollution. Abgerufen am 10. March 2019 von Deccan Chronicle: https://www.deccanchronicle.com/nation/in-other-news/251116/kochi-unaware-of-noise-pollution.html

Edathoot, A. (27. April 2018). Case Study: Kochi. Abgerufen am 05. April 2019 von https://sswm.info

Ganesan, P. (2017). Landfill sites, solid waste management and people's resistance: a study of two municipal corporations in Kerala. International Journal of Environmental Studies .

Giri, G. G. (08. September 2018). Kochi ranks 5th in lowest overall emissions. Abgerufen am 05. April 2019 von The Times of India: https://timesofindia.indiatimes.com/city/kochi/kochi-ranks-5th-in-lowest-overall-emissions/articleshow/65728190.cms

GIZ. (30. January 2018). Together for Clean Kochi - Source Segregation for SWM, Kochi, Kerala. Case study tutorial on source segregation, Kochi under the Swachh Bharat Mission of Government of India . Sustainable Sanitation Alliance (SuSanA).

Government of Kerala. (2014). Perspective Plan 2030 - Kerala: Entrepreneurialism and Environmental Sustainability. State Planning Board (Government of Kerala).

ICLEI-South Asia. (2015). Green Growth Profiles of Ten Indian Cities. Delhi, India: ICLEI-South Asia.

K K, H., Lukose, P., & Rajesh, R. (2016). Solid Waste Management in Cochin, India: Practices, Challenges and Solutions. Journal of Basic and Applied Engineering Research , 3 (9), 746-751.

KMC. (07. December 2017). Clean Air Aisa organises multi-stakeholder consultation. Abgerufen am 04. July 2019 von Kochi Municipal Corporation: https://cochinmunicipalcorporation.kerala.gov.in/documents/10157/da83312c-0a38-4741-a088-65d041096d27

KMC. (2019). Smart City. Abgerufen am May 22 2019 von Kochi Municipal Corporation: https://cochinmunicipalcorporation.kerala.gov.in/web/guest/smart-city1

KSPCB. (2014b). Ambient Monitoring. Abgerufen am 15. February 2019 von Kerala State Pollution Control Board: https://www.keralapcb.nic.in/#

KSPCB. (2014a). Kerala State Pollution Control Board: Annual Report 2013-2014.

KSPCB. (2014). Water and Air Pollution. Abgerufen am 15. February 2019 von Kerala State Pollution Control Board: https://www.keralapcb.nic.in/#

KSUDP. (2017). Kochi City Development Plan:Environment. Abgerufen am 15. May 2019 von Kerala Sustainable Urban Development Project: http://www.ksudp.org/images/cdp_kochi/environment.pdf

Nair, S. (2008). Challenges to the biodiversity in a fast-growing tropical city. In N. Müller, D. Knight, & P. Werner (Hrsg.), Urban Biodiversity & Design: Implementing the Convention on Biological Diversity in towns and cities. Bonn, Germany: BfN.

Nambudiri, S. (20. March 2017). Battling the wave of climate change. Abgerufen am 10. April 2019 von The Times of India: https://timesofindia.indiatimes.com/city/kochi/battling-the-wave-of-climate-change/articleshow/57725047.cms

Perinchery, A. (22. December 2018). Rapid urbanisation giving rise to heat islands in Kochi. Abgerufen am 06. February 2019 von The Hindu: https://www.thehindu.com/news/cities/Kochi/rapid-urbanisation-giving-rise-to-heat-islands-in-kochi/article25809737.ece

Rajagopal, S. (25. February 2019). Pollution from waste burning may linger for days. Abgerufen am 05. May 2019 von thehindu.com: https://www.thehindu.com/news/cities/Kochi/pollution-from-waste-burning-may-linger-for-days/article26367880.ece

Ravi, A., & Vishnudas, S. (2016). Waste Footprint of Kochi City, Kerala - An Analysis. International Conference on Sustainable Design, Engineering and Construction. SDEC.

SmartCity Kochi. (2018). SmartCity Kochi Masterplan features. Abgerufen am 16. May 2019 von http://smartcity-kochi.in/masterplan/master-plan-features/

Suchitra, M. (2015a). Kerala becomes first state in country to complete formation of biodiversity management committees. Abgerufen am 15. May 2019 von DownToEarth: https://www.downtoearth.org.in/news/kerala-becomes-first-state-in-country-to-complete-formation-of-biodiversity-management-committees-39335

Suchitra, M. (08. September 2015). Water quality deteriorating in Kochi, reveals audit. Abgerufen am 23. April 2019 von DownToEarth: https://www.downtoearth.org.in/news/water/water-quality-deteriorating-in-kochi-reveals-audit-51031

The Hindu. (20. August 2012). Abgerufen am 16. June 2019 von Kochi among cities with heavy pollution: https://www.thehindu.com/news/cities/Kochi/kochi-among-cities-with-heavy-pollution/article3798444.ece

The Hindu. (20. September 2010). Steps to control pollution in Greater Kochi area mooted. Abgerufen am 22. March 2019 von The Hindu: https://www.thehindu.com/news/cities/Kochi/Steps-to-control-pollution-in-Greater-Kochi-area-mooted/article15992537.ece

The new Indian Express. (14. July 2015). Kerala Perspective Plan 2030 Unveiled. Abgerufen am 05. May 2019 von The new Indian Express: http://www.newindianexpress.com/cities/thiruvananthapuram/2015/jul/14/Kerala-Perspective-Plan-2030-Unveiled-783617.html

The new Indian Express. (11. March 2019). Kochi: Keeping decibels in check. Abgerufen am 20. March 2019 von The new Indian Express: http://www.newindianexpress.com/cities/kochi/2019/mar/11/kochi-keeping-decibels-in-check-1949392.html

Thomas, G., ShareekulAnsar, S. A., & Zachariah, E. (2014). Analysis of urban heat island in Kochi, India, using a modified local climate zone classification. Procedia Environmental Science , 21, 3-13.

TNN. (16. May 2019a). KMRL starts preparatory works for Kochi metro Phase II. Abgerufen am 20. May 2019 von The Times of India: https://timesofindia.indiatimes.com/city/kochi/kmrl-starts-preparatory-works-for-metro-phase-ii/articleshow/69349757.cms

TNN. (02. December 2019). Slight improvement in city's sound pollution. Abgerufen am 20. February 2019 von The Times of India: https://timesofindia.indiatimes.com/city/kochi/Slight-improvement-in-citys-sound-pollution/articleshow/55734811.cms

Urbanemissions. (2015). City - Kochi, India. Abgerufen am 20. April 2019 von urbanemissions.info: http://www.urbanemissions.info/india-apna/kochi-india/

WRI India. (07. June 2018). Creating a Roadmap for Zero Carbon Buildings in Kochi. Abgerufen am 16. January 2019 von WRI India: https://wri-india.org/events/creating-roadmap-zero-carbon-buildings-kochi

Case Study: Cape Town, South Africa

City of Cape Town (2001): Water Demand Management Policy

City of Cape Town (2005): Air Quality Management Plan (AQMP) Available at: http://www.saaqis.org.za/documents/City%20of%20CT%20Plan%20-%20Air%20Quality%20Management%20Plan%2015%20Aug%202008.pdf

City of Cape Town (2007): Long-Term Water Conservation and Water Demand Management Strategy

City of Cape Town (2010): Water By-Law

City of Cape Town (2018): Water Amendment By-Law

City of Cape Town (2012): City of Cape Town City Development Strategy. Available at: https://resource.capetown.gov.za/documentcentre/Documents/City%20strategies,%20plans%20and%20frameworks/CDS.pdf

City of Cape Town (2014): Update and Additions to Existing Long-Term Water Conservation and Water Demand Management Strategy – Review 2015/16

City of Cape Town (2015): The Cape Town Bioregional Plan (Policy Number 44854)

City of Cape Town (2016): Air Quality Management By-Law. Promulgated 17 August 2016 PG 7662; LA 54049

City of Cape Town (2017): Five year integrated development plan 2017-2022. Cape Town Executive Summary. Available at: http://resource.capetown.gov.za/documentcentre/Documents/City%20strategies,%20plans%20and%20frameworks/IDP%202017-2022%20Executive%20Summary.pdf

City of Cape Town (2017): Climate Change Policy. Policy Number 46824

City of Cape Town (2018): Biodiversity Report 2018.

City of Cape Town (2018): The city of Cape Town State of the Environment Report 2018.

Department of Environmental Affairs of South Africa (2018): THE 2017 National Framework for Air Quality Management in the RSA. No 41996, Government Gazette. Available at: https://cer.org.za/wp-content/uploads/2018/10/National-Environmental-Managerment-Air-Quality-Act-39-2004-the-2017-National-20181026-GGN-41996-01144.pdf

Enqvist ,Johan P. ; Ziervogel, Gina (2019): Water governance and justice in Cape Town: An overview. In: WIREs Water 6 (4), https://doi.org/10.1002/wat2.1354

GreenCape (2018): 2018 Waste Market Intelligence Report. Cape Town: GreenCape

Sinclair-Smith, K.; Winter, K. (2018): Water demand management in Cape Town. Managing Water Security in a Changing Climate. In: Scott, D., New, M. and Davies, H (eds.) (2018). Climate Change and Urban Develoment: Lessons from Cape Town. UCT Press.

Slingsby, Jasper; February, Ed; Rebelo, Toni (2018): Water: at what cost to our unique flora? In: Veld & Flora, Volume 104 Number 2, 2018, p. 72 - 75

StatsSA (2016): Community Survey 2016. Available online at: http://cs2016.statssa.gov.za

Van Der Merwe, Johannes (2015): Cape Town and its path to sustainability. Available at: http://citiesprogramme.com/wp-content/uploads/2015/05/Case-Study-Cape-Town-Sustainability.pdf

Website City of Cape Town: http://www.capetown.gov.za/City-Connect/Report/Report-noise-pollution/Report-a-noise- disturbance)

Western Cape Government (2018): State of Environment Outlook Report for the Western Cape Province. Air Quality. February 2018. Available at: https://www.westerncape.gov.za/eadp/files/atoms/files/08_Air%20Quality.pdf

Case Study: Jakarta, Indonesia

AirVisual (2018): 2018 World Air Quality Report. Region & City PM2.5 Ranking. https://www.airvisual.com/world-most-polluted-cities.

Amanda, M. (2012): Governor Regulation of DKI Jakarta Number 38 of 2012 on Green Building. http://www.indonesiarealestatelaw.com/summary-of-regulations/governor-regulation-of-dki-jakarta-number-38-of-2012-on-green-building/.

Andriani, D. (2015): A Glance at the World: Current Status of Waste Management in Indonesia. https://www.researchgate.net/publication/292986690_A_Glance_at_the_World_Current_Status_of_Waste_Management_in_Indonesia.

[CAI-Asia] Clean Air Initiative for Asian Cities Center (2010): Indonesia: Air Quality Profile. October 2010. http://www.indiaenvironmentportal.org.in/files/Indonesia_Air_Quality_Profile_-_2010_Edition.pdf.

Conservation International (2017): What are the issues? http://www.conservation.org/where/Pages/Indonesia.aspx.

C40 Jakarta (n.d.): Connecting Delta Cities. http://www.deltacityofthefuture.nl/cities/jakarta/climate-change-adaptation.

[EP&T and DIM] EP&T and Dharma Ina Mandiri (2017): Waste Management Master Plan, DKI Jakarta, Promoting Intermediate Treatment Facilities. Revision of the Waste Management Master Plan, DKI Jakarta – Indonesia. Case Number 2017-15710. http://esp3.org/index.php/en/library/papers-and-reports/306-revision-waste-management-master-plan-for-dki-jakarta.

Government of the Province of Jakarta Capital Special Territory (2012a): Jakarta Green Building User Guide. Vol. 5. Water Efficiency. https://greenbuilding.jakarta.go.id/files/userguides/Vol-5-WaterEfficiency-UserGuide.pdf.

Government of the Province of Jakarta Capital Special Territory (2012b): Jakarta Green Building. https://greenbuilding.jakarta.go.id/index-en.html.

Governor Regulation No. 38 on the Green Building Regulation (2012). Jakarta Capital Special Region Province. https://www.carbonmechanisms.de/fileadmin/media/dokumente/sonstige_downloads/Panidta_2013_Green_Building_Regulation_in_Jakarta_eng.pdf.

Governor Regulation No. 131 (2012): Action Plan for reducing area greenhouse gas emissions DKI Jakarta Province. http://jakberketahanan.org/wp-content/uploads/2018/10/Ibu-Fitri_RAD-GRK_Dinas-Lingkungan-Hidup-DKI-Jakarta.pdf.

Hartono, D.M. (2018): Water Supply of Jakarta. United Nation Industrial Development Organization. http://www.unido.or.jp/files/sites/2/Water-Supply-in-Jakarta.pdf.

Hecht, J.E. (2016): Indonesia: Costs of Climate Change 2050. United States Agency for International Development. Climate Change Adaptation Thought Leadership, and Assessments (ATLAS). https://www.climatelinks.org/sites/default/files/asset/document/Indonesia%20Costs%20of%20CC%202050%20Policy%20Brief.pdf.

Hendarto, H., & Standing, J. R. (2019). Influence of groundwater extraction on land subsidence in Jakarta. Proceeding of the XVII ECSMGE, 1-8.

[IEA] International Energy Agency (2015): Indonesia. https://www.iea.org/policiesandmeasures/energyefficiency/?country=Indonesia

Indonesia Habitat National Team (2016): Indonesia National Report for Habitat III. http://habitat3.org/wp-content/uploads/National-Report_INDONESIA.pdf

Kusumaningtyas, S. D. A., Aldrian, E., Wati, T., Atmoko, D., & Sunaryo, S. (2018): The recent state of ambient air quality in Jakarta. Aerosol and Air Quality Research, 18(9), 2343-2354.

Lestari, P., Damayanti, S., Arrohman, M.K. (2020): Emission Inventory of Pollutants (CO, SO2, PM2.5, and NOX) in Jakarta Indonesia. In IOP Conference Series: Earth and Environmental Science (Vol. 489, No.1).

Ministry of National Development (2012): The Simulation Study on Climate Change in Jakarta, Indonesia. https://openjicareport.jica.go.jp/pdf/12150934.pdf.

Nalang, V. (n.d.): Indonesian Biodiversity and Action Plan 2003-2020. https://www.cbd.int/doc/meetings/nbsap/nbsapcbw-seasi-01/other/nbsapcbw-seasi-01-id-en.pdf.

Nasution, Achmad Delianur & Zahrah, Wahyuni (2014): Community Perception on Public Open Space and Quality of Life in Medan, Indonesia. https://ac.els-cdn.com/S1877042814055335/1-s2.0-S1877042814055335-main.pdf?_tid=f75366a5-3035-4b3a-8047ebaada6a122a&acdnat=1525426233_fac53e989e9a3abdb9fd41ea31bb7ddb.

[RAN] Rainforest Action Network (n.d.): Indonesia´s Rainforests: Biodiversity and Endangered Species. https://www.ran.org/indonesia_s_rainforests_biodiversity_and_endangered_species/.

Regional Regulation of the Province of Jakarta Capital Special Region No. 2/2005. Air pollution. http://extwprlegs1.fao.org/docs/pdf/ins52263.pdf.

Regulation of the Governor of Jakarta, No. 25/2011. http://extwprlegs1.fao.org/docs/pdf/ins112966.pdf.

Report on Greenhouse Gas Emissions in DKI Jakarta (2019): https://lingkunganhidup.jakarta.go.id/files/Laporan_Akhir_PEP_DKI_Jakarta_2019.pdf.

[UAQ-i] Urban Air Quality Improvement Program (2006): Indonesia: Preparing the Urban Air Quality Improvement Sector Development Program. Final Report. https://www.adb.org/sites/default/files/project-document/66623/37301-ino-tacr.pdf.

United Nations (2018): World Urbanization Prospects. https://population.un.org/wup/Download/.

[UNU-IAS] United Nations University (2015): Overview over Jakarta Water -Related Environmental Challenges.http://collections.unu.edu/eserv/UNU:2872/WUI_WP4.pdf.

Urbanemissions (2017): Air quality management laws, policies and programs in Jakarta. http://www.urbanemissions.info/wp-content/uploads/docs/2017-01-Jakarta-Facsheet5-AQM-Actions-in-Indonesia.pdf.

Widya Yudha, S. (2017): Air Pollution and its Implications for Indonesia: Challenges and Imperatives for Change. http://pubdocs.worldbank.org/en/183201496935944434/200417-AirQualityAsia-Air-Pollution.pdf.

Worldbank (2010): Indonesia Rising. Policy Priorities for 2010 and Beyond. Mainstreaming Climate Change for Sustainability. http://documents.worldbank.org/curated/en/803651468039864174/pdf/534750BRI0710c10Box345611B01PUBLIC1.pdf.

Worldbank (2017): Improvement of Solid Waste Management to Support Regional and Metropolitan Cities. http://documents.worldbank.org/curated/en/640491496386470384/pdf/PIDISDS-CON-Print-P157245-06-02-2017-1496386463379.pdf.

World's Capital Cities (n.d.): Capital Facts for Jakarta, Indonesia.https://www.worldscapitalcities.com/capital-facts-for-jakarta-indonesia/.

Final Chapters

BMUB 2017: Mobilising Finance for Mitigation and Climate Change Adaptation. Available at: https://www.international-climate initiative.com/fileadmin/Dokumente/2017/171109_IKI_FS_Klimafinanzierung.pdf